



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety
Washington, D.C. 20594

May 23, 2012

Group Chairman's Factual Report

METEOROLOGY

ERA12FA115

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A. ACCIDENT

Location: Morristown, New Jersey
Date: December 20, 2011
Time: about 1005 eastern standard time (1505 UTC¹)
Aircraft: Socata TBM 700, registration: N731CA

B. METEOROLOGY GROUP

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C. SUMMARY

On December 20, 2011, about 1005 eastern standard time (EST), a Socata TBM 700, N731CA, collided with terrain following an in-flight loss of aircraft control near Morristown, New Jersey. The airplane was registered to Cool Stream LLC and was operated by the pilot. Visual meteorological conditions prevailed and an instrument flight rules flight plan was filed for the flight from Teterboro, New Jersey (TEB), to Atlanta, Georgia (PDK). The personal flight was conducted under the provisions of 14 Code of Federal Regulations Part 91. The airplane sustained substantial damage. The certificated private pilot and four passengers were fatally injured. The flight originated from TEB at 0950.

D. DETAILS OF THE INVESTIGATION

The National Transportation Safety Board's (NTSB) Meteorology Group was not on scene and gathered weather data for this investigation from the NTSB headquarters in Washington, D.C., as well as the National Weather Service's (NWS) headquarters located in Silver Spring, Maryland. All times are in EST on December 20, 2011, except where noted, and are based upon the 24-hour clock. Directions are referenced to true north and distances in nautical miles. Heights are above mean sea level (msl) unless otherwise noted. Visibility is in statute miles (sm) and fractions of sm. Distances along the surface of the earth are calculated using the "Great Circle" formula.

¹ UTC – abbreviation for Coordinated Universal Time

Coordinates used for the accident location (approximate): 40.77833° North latitude, 74.4817° West longitude.

E. FACTUAL INFORMATION

1. Synoptic Conditions

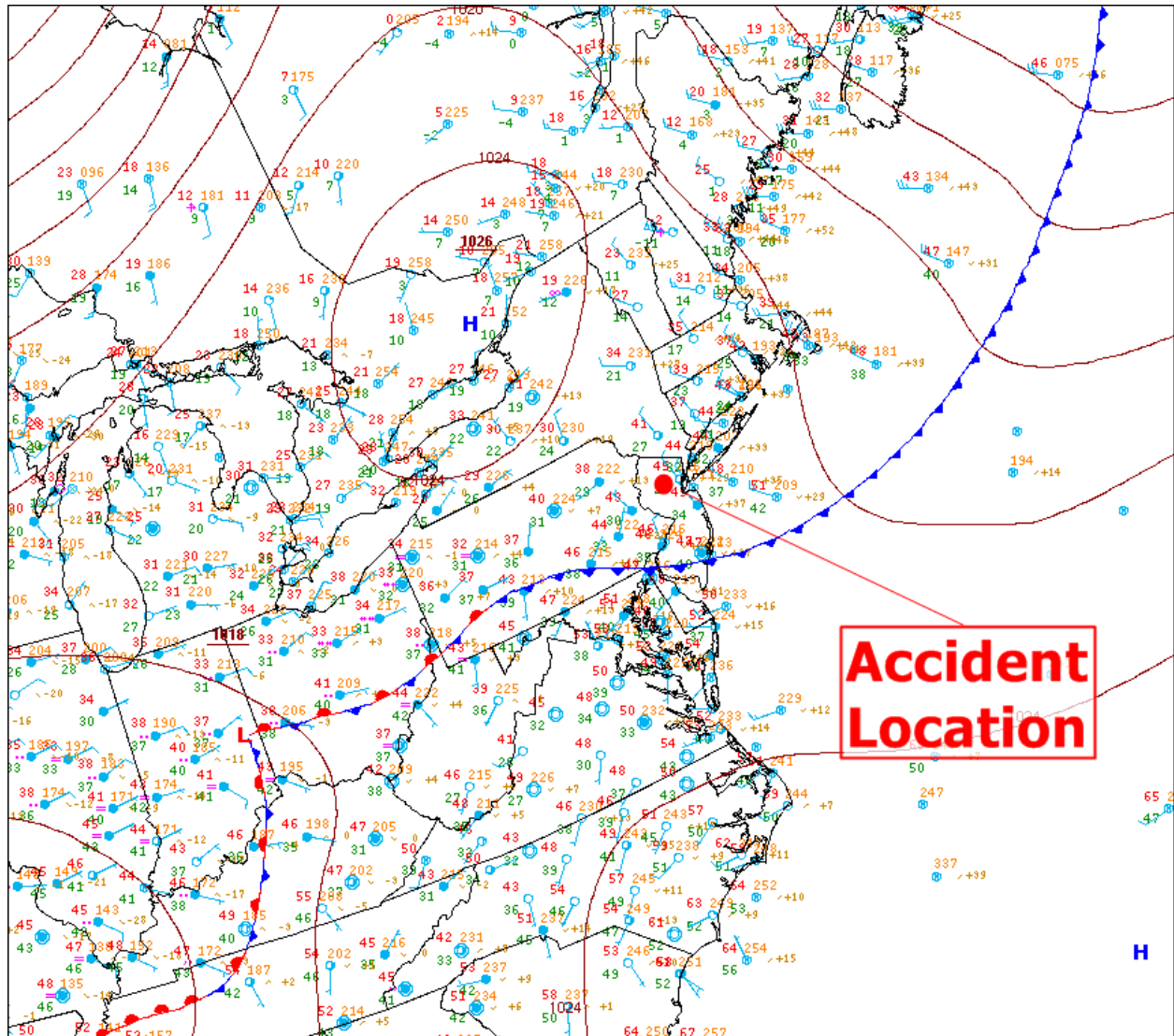


Figure 1 – NWS Surface Analysis Chart for 1000 EST.

The National Weather Service (NWS) Surface Analysis Chart for 1000 EST is included as figure 1. The chart depicted a low pressure center near the Indiana/Ohio border with a stationary front extending east through Ohio into western Pennsylvania. A cold front extended from this point

eastward through southern Pennsylvania and southern New Jersey, and continued over coastal waters. A high pressure center was depicted near the Ontario/New York/Lake Ontario border. Most station models throughout Pennsylvania and New Jersey indicated overcast conditions, while many station models in southern New York and Connecticut depicted partly cloudy or clear skies. North and east of the accident location the wind was generally from the north or northeast at magnitudes around 10 knots. Wind directions west and south of the accident were variable, however most station models depicted a northerly or northeasterly wind behind the cold front at magnitudes around 5-10 knots. Surface temperatures behind the cold front in the accident region ranged from the high 30's° Fahrenheit (F) to the mid-40's°F with dew point depressions around 10 degrees or greater. No present weather symbols were depicted in the accident region.

An NWS Storm Prediction Center (SPC) 850-hectopascal (hPa) analysis chart for 0700 EST is provided in Figure 2. Dew point temperatures are not plotted for values less than 8° Celsius (C). The chart depicted a ridge oriented north-northeastward/south-southwestward from Ohio to Quebec, as well as a trough oriented northeastward/southwestward from New Brunswick to Pennsylvania. Isotherms are observed to be well packed over New England and south to Virginia.

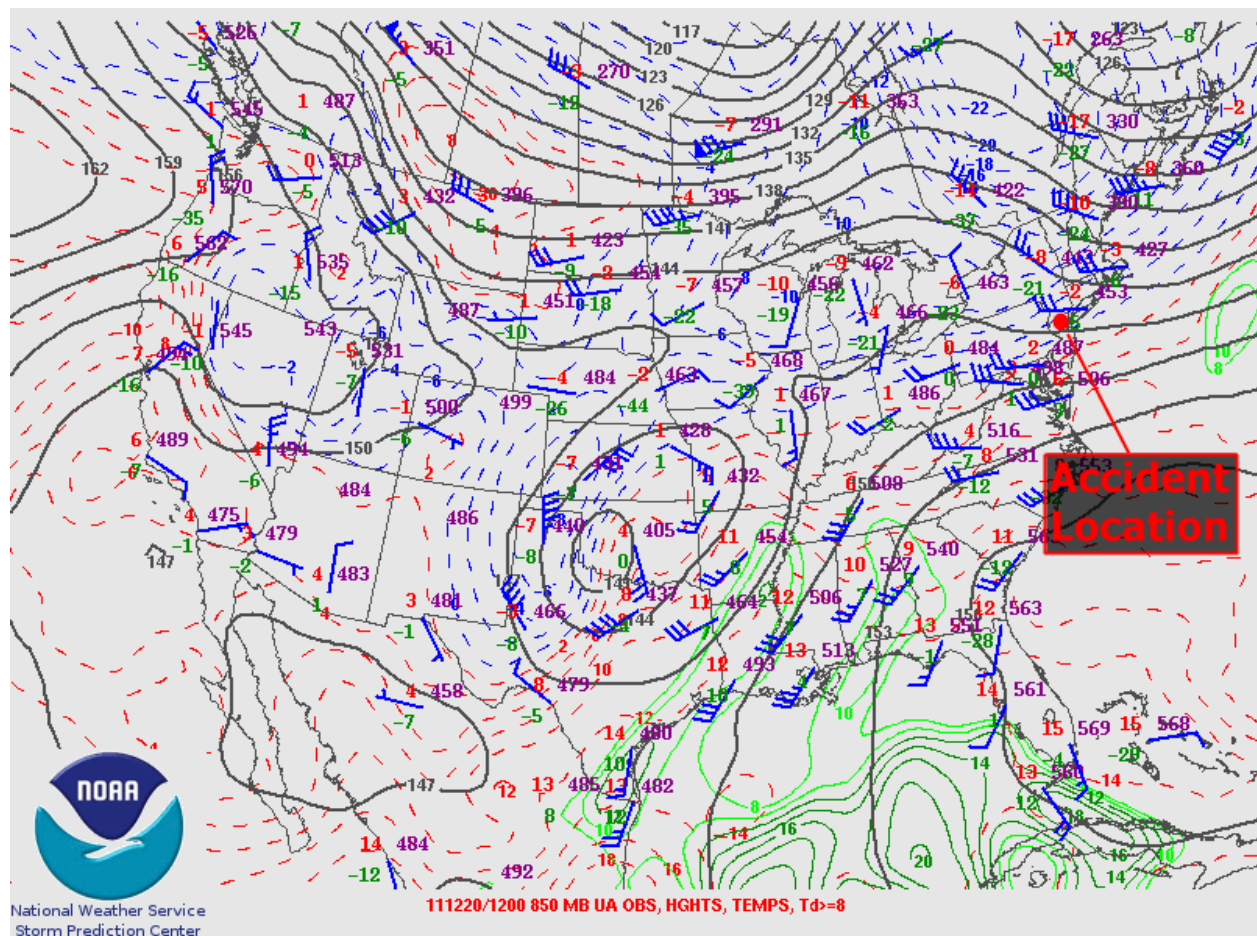


Figure 2 – NWS SPC 850 hPa analysis for 0700 EST.

2. Aviation Routine Weather Reports

Surface observations from the accident region were documented for the period surrounding the accident time. Locations of these stations are presented in figure 3. Cloud heights in this section are reported above ground level (agl).

2.1 Morristown Municipal Airport Observations

Morristown Municipal Airport (KMMU) in Morristown, New Jersey, was located about 3 miles to the east-northeast of the accident site at an elevation of 187 feet. These reports were issued while a weather observer was logged into the reporting system. Presented here are some of the publically disseminated surface observations from KMMU from December 20, 2011.

[0645 EST] METAR KMMU 201145Z 36008G15KT 7SM SCT250 07/01 A3009
[0745 EST] METAR KMMU 201245Z 35007G14KT 7SM BKN250 06/00 A3014
[0845 EST] METAR KMMU 201345Z 36010G14KT 10SM OVC200 06/M01 A3017
[0945 EST] METAR KMMU 201445Z 36008G13KT 10SM OVC200 06/M02 A3017
[1045 EST] METAR KMMU 201545Z 02005KT 10SM BKN110 06/M02 A3018
[1144 EST] METAR KMMU 201644Z 35007KT 10SM BKN110 06/M02 A3016

At 0945 EST, KMMU reported wind from 360° at 8 knots with gusts to 13 knots, visibility of 10 miles or greater, ceiling overcast at 20,000 feet, temperature 6°C, dew point temperature -2°C, altimeter setting 30.17 inches of Mercury.

At 1045 EST, KMMU reported wind from 020° at 5 knots, visibility of 10 miles or greater, ceiling broken at 11,000 feet, temperature 6°C, dew point temperature -2°C, altimeter setting 30.18 inches of Mercury.

2.2 Essex County Airport Observations

Essex County Airport (KCDW) in Caldwell, New Jersey, was located about 11 miles to the northeast-east of the accident site at an elevation of 172 feet. These reports were issued while a weather observer was logged into the reporting system. Presented here are some of the publically disseminated surface observations from KCDW from December 20, 2011.

[0653 EST] METAR KCDW 201153Z 32004KT 10SM OVC048 07/00 A3010 RMK
AO2 SLP200 T00670000 10083 20067 53031
[0753 EST] METAR KCDW 201253Z 34005KT 10SM BKN048 OVC070 06/M01
A3015 RMK AO2 SLP214 T00611011

[0853 EST] METAR KCDW 201353Z 33007KT 10SM FEW070 06/M01 A3017 RMK AO2 SLP223 T00611011

[0953 EST] **METAR KCDW 201453Z VRB04KT 10SM CLR 06/M01 A3018 RMK AO2 SLP225 T00561011 51025**

[1053 EST] **METAR KCDW 201553Z 00000KT 10SM FEW120 06/M02 A3018 RMK AO2 SLP225 T00561017**

[1153 EST] METAR KCDW 201653Z VRB04KT 10SM OVC120 06/M03 A3016 RMK AO2 SLP219 T00561033

At 0953 EST, KCDW reported a variable wind at 4 knots, visibility of 10 miles or greater, sky clear², temperature 6°C, dew point temperature -1°C, altimeter setting 30.18 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1022.5 hPa, hourly temperature 5.6°C and hourly dew point temperature -1.1°C, pressure increased 2.5 hPa in past 3 hours.

At 1053 EST, KCDW reported a calm wind, visibility of 10 miles or greater, few clouds at 12,000 feet, temperature 6°C, dew point temperature -2°C, altimeter setting 30.18 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1022.5 hPa, hourly temperature 5.6°C and hourly dew point temperature -1.7°C, pressure increased 2.5 hPa in past 3 hours.

2.3 Somerset Airport Observations

Somerset Airport (KSMQ) in Somerville, New Jersey, was located about 12 miles to the southwest of the accident site at an elevation of 105 feet. These automated reports were issued while a weather observer was not logged into the reporting system. Presented here are some of the publically disseminated surface observations from KSMQ from December 20, 2011.

[0653 EST] METAR KSMQ 201153Z AUTO 35009G16KT 10SM FEW041 08/01 A3009

[0753 EST] METAR KSMQ 201253Z AUTO 33007KT 10SM BKN039 07/M01 A3012 RMK AO2 SLP202 T00721006

[0853 EST] METAR KSMQ 201353Z AUTO 02004KT 10SM SCT043 BKN070 BKN120 07/M01 A3015 RMK AO2 SLP211 T00671011

[0953 EST] **METAR KSMQ 201453Z AUTO 34006KT 10SM OVC120 07/M02 A3016 RMK AO2 SLP216 T00671022 51026**

[1053 EST] **METAR KSMQ 201553Z AUTO 01005KT 10SM OVC110 07/M03 A3015 RMK AO2 SLP211 T00671033**

² A sky clear (CLR) report may mean no clouds below 12,000 feet agl.

[1153 EST] METAR KSMQ 201653Z AUTO 34004KT 10SM BKN060 07/M03 A3015
RMK AO2 SLP210 T00671033

At 0953 EST, KSMQ reported a wind from 340° at 6 knots, visibility of 10 miles or greater, ceiling overcast at 12,000 feet, temperature 7°C, dew point temperature -2°C, altimeter setting 30.16 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1021.6 hPa, hourly temperature 6.7°C and hourly dew point temperature -2.2°C, pressure increased 2.6 hPa in past 3 hours.

At 1053 EST, KSMQ reported a wind from 010° at 5 knots, visibility of 10 miles or greater, ceiling overcast at 11,000 feet, temperature 7°C, dew point temperature -3°C, altimeter setting 30.15 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1021.1 hPa, hourly temperature 6.7°C and hourly dew point temperature -3.3°C.

2.4 Newark Liberty International Airport Observations

Newark Liberty International Airport (KEWR) in Newark, New Jersey, was located about 15 miles to the east-southeast of the accident site at an elevation of 18 feet. These reports were issued while a weather observer was logged into the reporting system. Presented here are some of the publically disseminated surface observations from KEWR from December 20, 2011.

[0651 EST] METAR KEWR 201151Z 31013KT 10SM FEW035 SCT110 BKN130
08/01 A3009 RMK AO2 SLP187 T00830006 10089 20072 53024

[0751 EST] METAR KEWR 201251Z 32010G19KT 10SM FEW035 SCT110 BKN130
08/M01 A3013

[0851 EST] METAR KEWR 201351Z 33010KT 10SM FEW040 SCT110 BKN130
07/M01 A3016 RMK AO2 SLP212 T00721011

**[0951 EST] METAR KEWR 201451Z 35012G19KT 10SM FEW040 BKN120
07/M02 A3017 RMK AO2 SLP216 T00721017 51029**

**[1051 EST] METAR KEWR 201551Z 35010KT 10SM FEW040 BKN110 07/M02
A3017 RMK AO2 SLP216 T00671017**

[1151 EST] METAR KEWR 201651Z 36010KT 10SM FEW040 OVC110 07/M03
A3017 RMK AO2 SLP214 T00671028

At 0951 EST, KEWR reported a wind from 350° at 12 knots with gusts to 19 knots, visibility of 10 miles or greater, few clouds at 4,000 feet, ceiling broken at 12,000 feet, temperature 7°C, dew point temperature -2°C, altimeter setting 30.17 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1021.6 hPa, hourly temperature 7.2°C and hourly dew point temperature -1.7°C, pressure increased 2.9 hPa in past 3 hours.

At 1051 EST, KEWR reported a wind from 350° at 10 knots, visibility of 10 miles or greater, few clouds at 4,000 feet, ceiling broken at 11,000 feet, temperature 7°C, dew point temperature -2°C, altimeter setting 30.17 inches of Mercury. Remarks: station with a precipitation

discriminator, sea-level pressure 1021.6 hPa, hourly temperature 6.7°C and hourly dew point temperature -1.7°C.

2.5 Teterboro Airport Observations

Teterboro Airport (KTEB) in Teterboro, New Jersey, was located about 20 miles to the east-northeast of the accident site at an elevation of 9 feet. These automated reports were issued while a weather observer was not logged into the reporting system. Presented here are some of the publically disseminated surface observations from KTEB from December 10, 2011.

[0651 EST] METAR KTEB 201151Z 33010KT 10SM CLR 08/M01 A3008 RMK AO2
SLP186 T00781011 10089 20072 53026

[0751 EST] METAR KTEB 201251Z 32008KT 10SM FEW070 07/M02 A3013 RMK
AO2 SLP201 T00671017

[0851 EST] METAR KTEB 201351Z 33007KT 10SM SCT070 07/M02 A3016 RMK
AO2 SLP211 T00671017

**[0951 EST] METAR KTEB 201451Z 34008KT 10SM CLR 07/M02 A3017 RMK
AO2 SLP215 T00671017 51028**

**[1051 EST] METAR KTEB 201551Z 34006KT 10SM CLR 07/M02 A3017 RMK
AO2 SLP216 T00671017**

[1151 EST] METAR KTEB 201651Z 35007KT 10SM OVC120 07/M02 A3015 RMK
AO2 SLP208 T00671022

At 0951 EST, KTEB reported a wind from 340° at 8 knots, visibility of 10 miles or greater, sky clear, temperature 7°C, dew point temperature -2°C, altimeter setting 30.17 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1021.5 hPa, hourly temperature 6.7°C and hourly dew point temperature -1.7°C, pressure increased 2.8 hPa in past 3 hours.

At 1051 EST, KTEB reported a wind from 340° at 6 knots, visibility of 10 miles or greater, sky clear, temperature 7°C, dew point temperature -2°C, altimeter setting 30.17 inches of Mercury. Remarks: station with a precipitation discriminator, sea-level pressure 1021.6 hPa, hourly temperature 6.7°C and hourly dew point temperature -1.7°C.

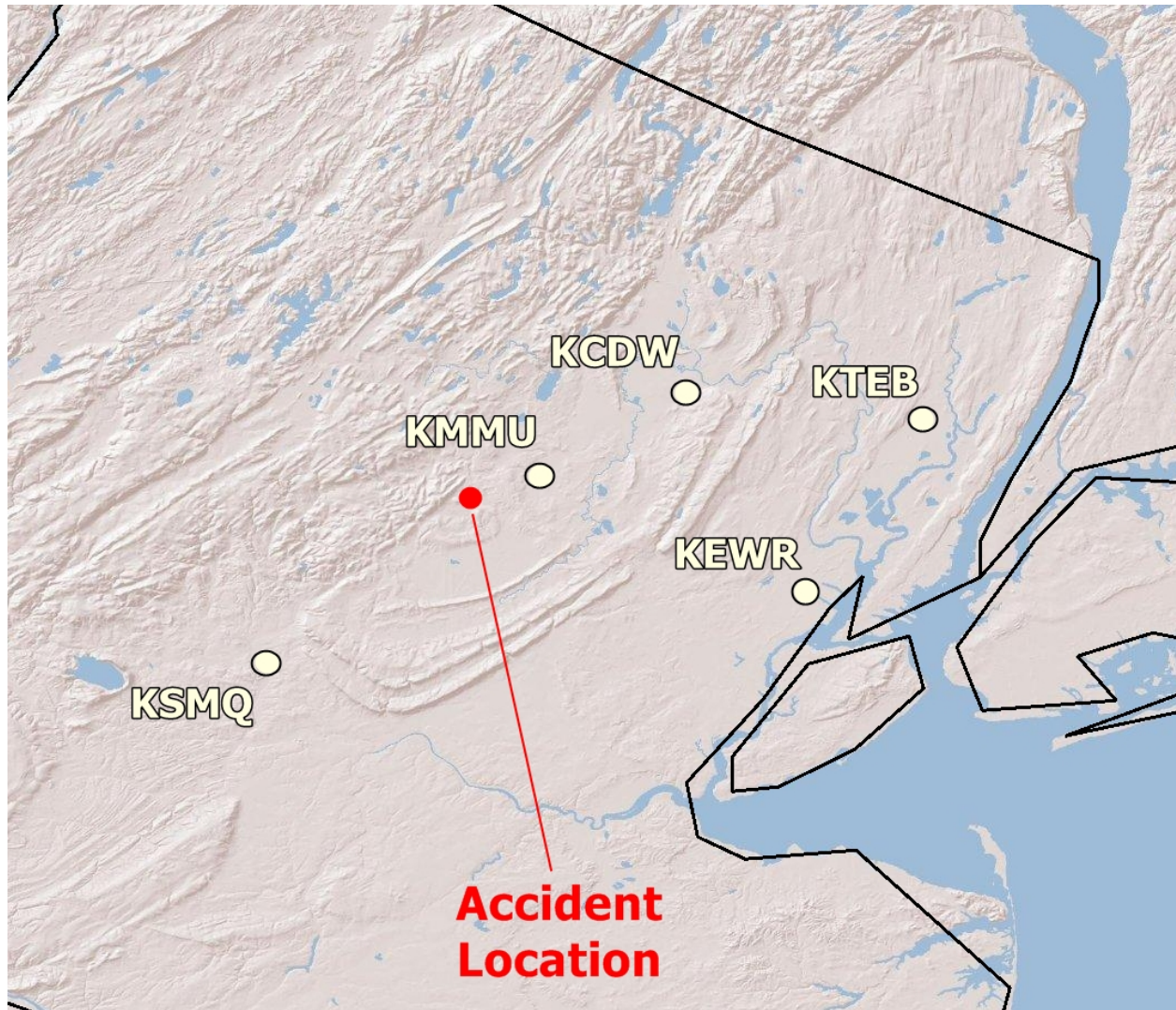


Figure 3 – Plot of surface station locations presented in this section.

3. Upper Air Data

3.1 Rawinsondes

Atmospheric data were retrieved from rawinsonde launches at 0700 EST from Upton, New York (OKX; station identifier 72501), from Albany, New York (ALB; station identifier 72518), and from the Aberdeen Proving Ground in Maryland (APG; station identifier 74002). These launches were located approximately 72 miles east, 108 miles north-northeast, and 111 miles southwest of the accident site, respectively. These data are presented in figures 4-6.

The OKX sounding indicated the majority of the troposphere was stable or conditionally unstable with a very shallow layer of instability near 18,000 feet. Inversions were noted near 6,000, 7,000, 13,000 and 17,000 feet. The relative humidity (RH) was greater than 90 percent between about 13,000 and 20,000 feet. The freezing level was approximately 4,000 feet.

Assessments of icing made by the Universal RAwinsonde OBbservation program (RAOB) for this sounding yielded the potential for moderate mixed and rime icing between about 13,000 and 18,000 feet.

The OKX wind profile identified a northwest wind near the surface at about 15 knots. The wind *backed*³ slightly with height an increased in magnitude to 57 knots at about 10,000 feet. Between 10,000 and 25,000 feet, the wind was generally from a westerly direction but increased in magnitude from 57 knots to 105 knots, respectively. The wind at 18,000 feet was westerly at about 100 knots. Calculations by RAOB indicated several layers of significant clear-air turbulence below 30,000 feet.

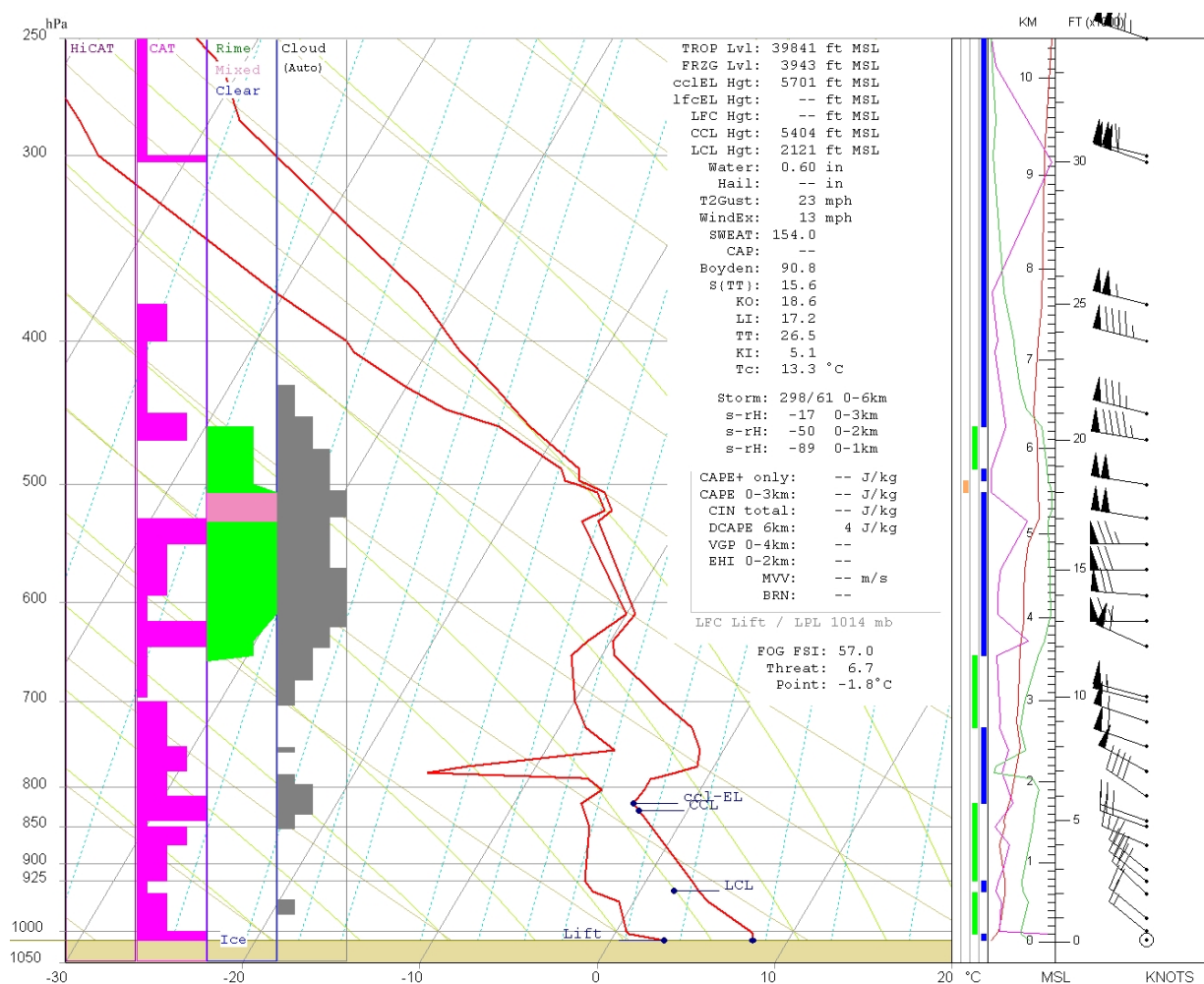


Figure 4 – Rawinsonde sounding from OKX in SkewT/LogP⁴ format for 0700 EST, surface to 250 hPa.

³ A “backing” wind is a wind that turns counter-clockwise with increasing height.

⁴ SkewT/LogP - A thermodynamic diagram, using the temperature and the logarithm of pressure as coordinates, which allows the plotting of the vertical profile of the temperature, humidity, and atmosphere above a particular point on the earth's surface.

The APG sounding indicated the majority of the troposphere was stable or conditionally unstable. Inversions were noted between 4,000 and 6,000 feet at near 14,000 feet. The relative RH was greater than 90 percent from about 8,000 to about 19,000 feet. The freezing level was

The APG sounding indicated the majority of the troposphere was stable or conditionally unstable. Inversions were noted between 4,000 and 6,000 feet at near 14,000 feet. The relative RH was greater than 90 percent from about 8,000 to about 19,000 feet. The freezing level was

approximately 7,800 feet. Assessments of icing made by RAOB for this sounding yielded the potential for light clear and rime icing between about 9,000 and 19,000 feet.

The APG wind profile identified a light southwest wind near the surface. The wind *veered*⁵ slightly with, and increased in magnitude to, 17 knots at about 4,000 feet. Above 4,000 feet, the wind was generally from a westerly direction but steadily increased in magnitude to about 80 knots at 21,000 feet. Calculations by RAOB indicated several layers of significant clear-air turbulence potential below 10,000 feet.

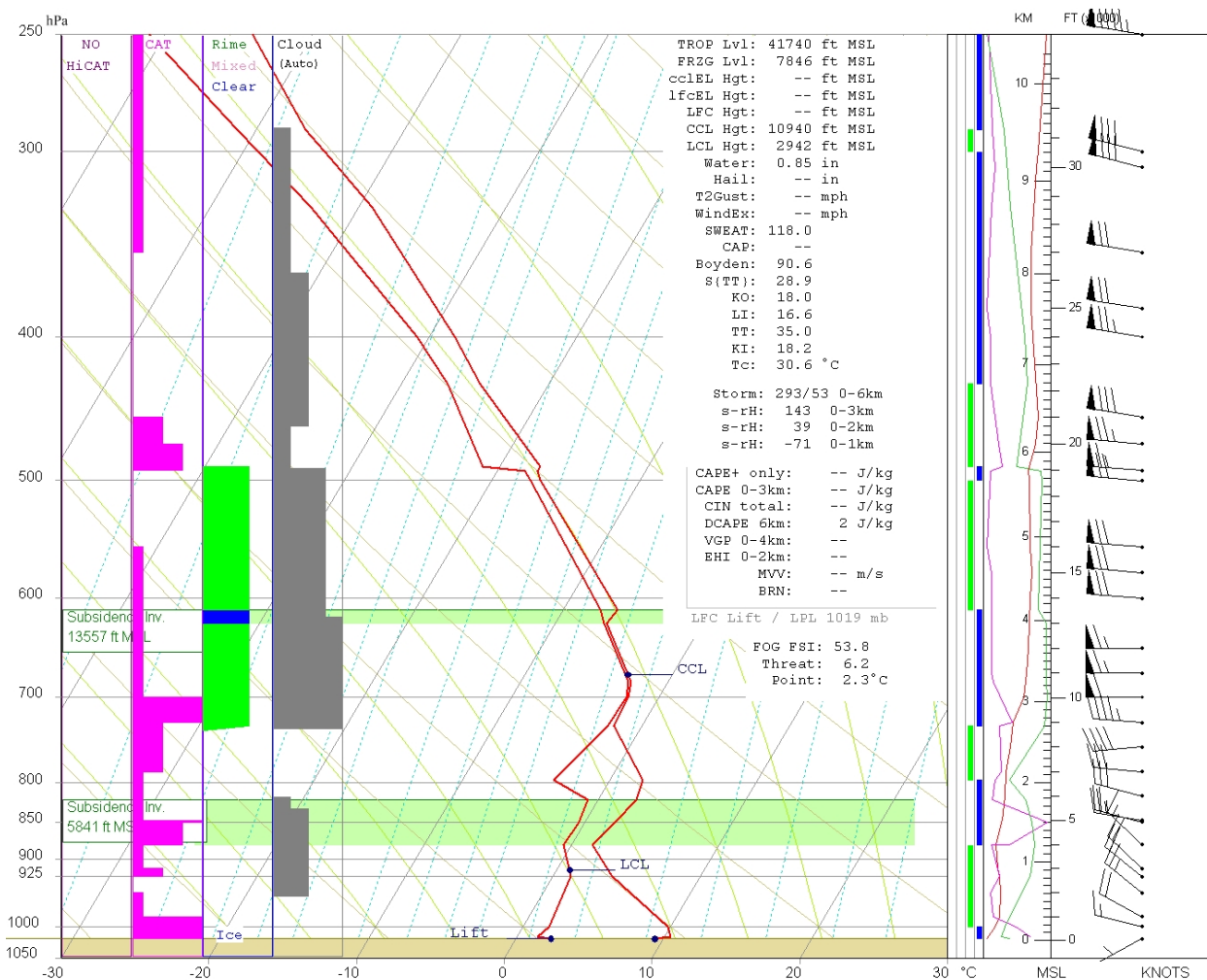


Figure 6 – Rawinsonde sounding from APG in SkewT/LogP format for 0700 EST, surface to 250 hPa.

As presented in the Air Traffic Control Group Chairman’s Specialist Report, the accident aircraft entered instrument meteorological conditions (IMC) at approximately 13,000 feet. According to

⁵ A “veering” wind is a wind that turns clockwise with increasing height.

the report, the total time between the accident aircraft entering IMC and the initiation of its descent was about five and a half minutes.

3.2 AMDAR data

AMDAR data⁶ from an aircraft departing from La Guardia Airport (KLGA) in New York, New York, and flying west over northern New Jersey around the accident time on December 20, 2011, is presented in table 1. The flight path for this aircraft is presented in figure 7.

<u>Time</u>	<u>Latitude</u>	<u>Longitude</u>	<u>Altitude(ft.)</u>	<u>Wind Dir.</u>	<u>Wind Speed(kts)</u>	<u>Temp(°C)</u>
0958	40.790	-73.868	0	350°	8	5.7
0958	40.790	-73.878	470	336°	10	4.7
0958	40.800	-73.878	830	331°	11	3.7
0958	40.800	-73.878	1100	338°	12	2.7
0958	40.810	-73.878	1320	339°	9	2.2
0958	40.820	-73.878	1500	355°	14	1.6
0958	40.820	-73.878	1630	358°	14	1.1
0958	40.830	-73.878	1800	348°	13	0.6
0958	40.840	-73.888	1910	348°	16	0.1
0959	40.840	-73.888	2170	352°	14	-0.1
0959	40.850	-73.888	2500	346°	17	-0.4
0959	40.850	-73.888	2760	343°	17	-0.9
0959	40.860	-73.888	2970	350°	17	-1.6
0959	40.870	-73.888	3300	349°	15	-2.4
0959	40.870	-73.888	3670	338°	15	-2.9
0959	40.900	-73.898	4670	306°	17	-2.6
1000	40.912	-73.929	5250	312°	22	-2.4
1000	40.922	-73.959	6480	283°	25	-5.1
1000	40.922	-73.989	7790	293°	37	-4.9
1001	40.922	-74.019	8960	284°	41	-3.6
1001	40.912	-74.049	10080	279°	45	-4.4
1001	40.912	-74.079	10580	283°	49	-5.6
1002	40.902	-74.109	10930	285°	50	-6.6
1002	40.892	-74.149	11260	288°	52	-6.9
1002	40.882	-74.189	12510	282°	57	-8.9
1003	40.872	-74.229	13970	277°	65	-11.6
1003	40.872	-74.259	15480	279°	81	-13.1
1003	40.862	-74.299	16500	279°	86	-14.9
1004	40.852	-74.329	16780	281°	87	-15.9
1004	40.842	-74.369	16780	280°	86	-15.9
1004	40.832	-74.409	16770	279°	87	-16.1

⁶ AMDAR is the generally-accepted worldwide term for automated weather reports from commercial aircraft. In this report, this definition excludes TAMDAR data.

1005	40.832	-74.439	16770	279°	85	-15.9
1005	40.822	-74.479	16780	280°	84	-15.9
1005	40.812	-74.519	16770	278°	84	-15.9
1006	40.802	-74.549	16790	281°	85	-15.9
1006	40.792	-74.589	16900	279°	85	-16.4
1006	40.782	-74.629	17490	279°	89	-15.9
1007	40.782	-74.669	18080	278°	86	-17.1
1007	40.772	-74.699	18480	279°	85	-18.1
1007	40.762	-74.739	18800	279°	83	-19.0
1012	40.682	-75.079	22100	281°	86	-25.0
1014	40.592	-75.279	24000	284°	82	-29.0

Table 1 – AMDAR data from aircraft departing KLGA. Altitude is feet above msl according to the International Standard Atmosphere and wind direction is referenced to true north.

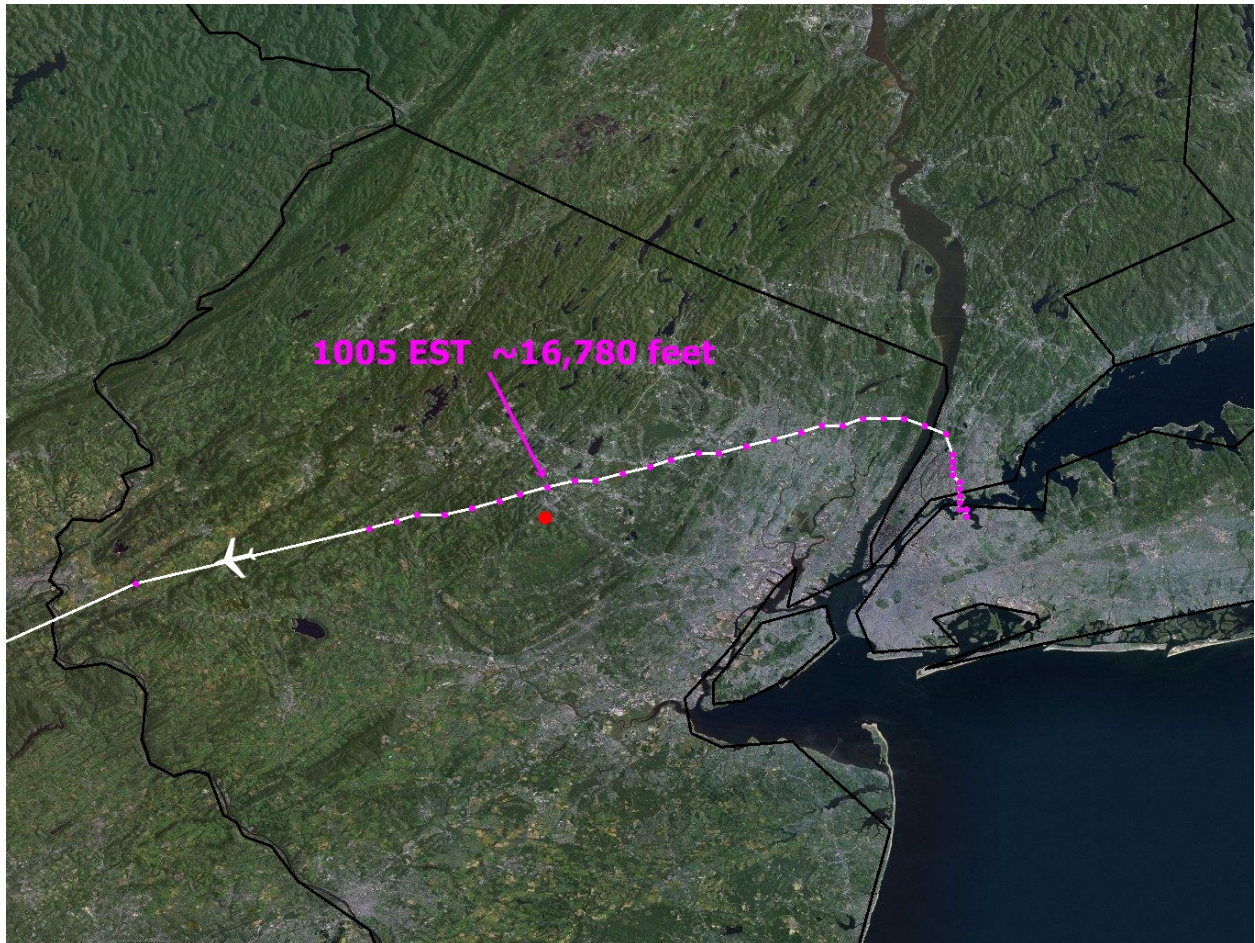


Figure 7 – Flight path (white line) below 24,000 feet for the AMDAR-reporting aircraft. Pink dots indicate reporting points. Red dot denotes accident location.

3.3 TAMDAR Data

Data retrieved by the Tropospheric Airborne Meteorological Data Reporting (TAMDAR) instrument, which is installed on numerous aircraft operating in the United States, was provided by AirDat LLC.⁷ Data and analysis from AirDat LLC, as well as flight paths from two aircraft operating near the accident site near the accident time, are presented in Attachment 1 to this report.

Large TAMDAR dataset was also provided by AirDat LLC. These data were obtained from aircraft operating within 200 miles of the accident location between 0700 and 1000 EST, and are presented in Attachment 2 to this report. Figure 8 depicts the flight paths for the aircraft that retrieved these TAMDAR data.

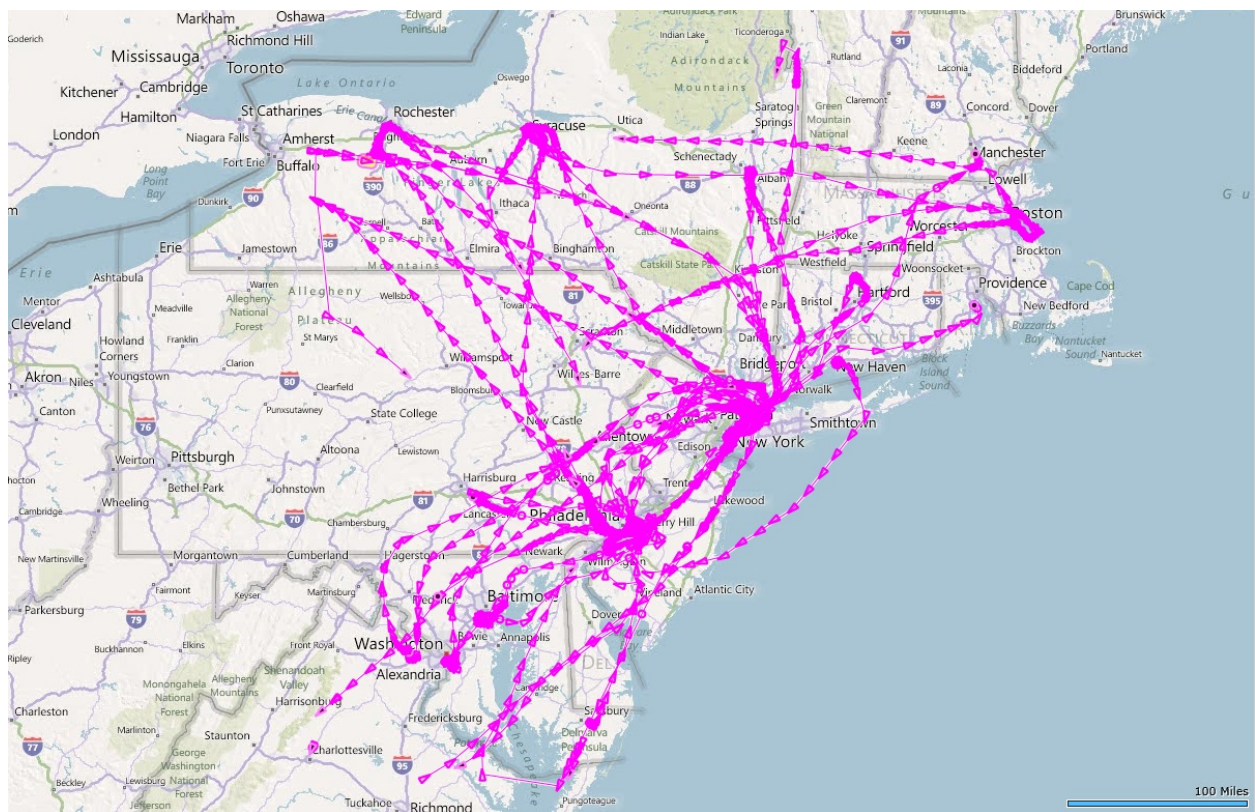


Figure 8 – Flight paths for aircraft that retrieved the TAMDAR data presented in Attachment 2 to this report.

⁷ TAMDAR data were provided courtesy of Dr. Neil Jacobs, Chief Atmospheric Scientist at AirDat LLC.

3.4 Model Data

Images presenting output from the Current Icing Product (CIP) and the Forecast Icing Product (FIP) surrounding the time of the accident were provided by the National Center for Atmospheric Research's (NCAR) Inflight Icing Product Development Team.⁸ These images represent what would have been available to the public via the Aviation Weather Center's (AWC) Aviation Digital Data Service (ADDS), and are presented in Attachment 3 to this report.

The CIP indicated that at 1000 EST, icing probabilities at altitudes between 13,000 feet and FL180⁹ were relatively high, with maximum probabilities near the accident location reaching 70-80 percent. In general, CIP icing severities at 1000 EST for these altitudes did not reach above "moderate," and there was no super-cooled large droplet (SLD) potential identified in the accident region. The CIP vertical cross-section provides a unique look at parameters such as super-cooled liquid water (SLW), vertical velocity (VERT VEL), and RH in the area of the accident at flight altitudes.

The FIP two- and three-hour forecasts that were valid at 1000 EST identified maximum icing probabilities near the accident between 13,000 feet and FL180 to be 60-70 percent. Icing severities for these products identified "light" icing along the accident routes, with some "moderate" icing areas nearby. The FIP products did identify some SLD potential near the accident area at lower altitudes.

3.5 Pilot Reports

Pilot reports made over New Jersey, southern New York, and eastern Pennsylvania between 0700 and 1300 EST are presented in Attachment 4 to this report.

There were three reports of severe icing included in this collection of reports:

PTW UUA /OV MXE240015/TM 1249/FL140/TP C56X/TA 0/IC MOD-SEV RIME
140-130=

An urgent pilot report at 0749 EST from a pilot operating a Cessna Citation Excel aircraft at 14,000 feet 15 nautical miles on the 240° radial from the Modena VORTAC in Modena, Pennsylvania, reported a temperature of 0°C, moderate to severe rime icing between 13,000 and 14,000 feet.

MMU UUA /OV MMU /TM 1308 /FL140 /TP MD83 /TA 04 /IC MOD-SEV RIME
140-165=

⁸ Courtesy of Mr. Cory Wolff, NCAR Associate Scientist.

⁹ Flight Level (FL) - standard nominal altitude of an aircraft, in hundreds of feet. This altitude is calculated from the International standard atmosphere using 1013.25 hPa (29.92 in.Hg) for surface pressure.

An urgent pilot report at 0808 EST from a pilot operating a MD-83 aircraft at 14,000 feet over KMMU, reported a temperature of 4°C, moderate to severe rime icing between 14,000 and 16,500 feet.

SMQ UUA /OV BWZ250030/TM 1542/FL140/TP MULTIPLE/IC MOD-SEV
RIME/RM ABE FL140-175=

An urgent pilot report at 1042 EST from “multiple” types of aircraft at 14,000 feet 30 nautical miles on the 250° radial from the Broadway VOR/DME in Schooley’s Mountain, New Jersey, reported moderate to severe rime icing between 14,000 and 17,500 feet.

A recording of New York Approach Liberty sector between 0800 and 0830 EST was acquired from an archive at *LiveATC.net*. This recording is unofficial, may be an incomplete record of air traffic control (ATC) communications on that sector and/or may contain ATC communications from other frequencies. At about 0806 EST, the following conversation was recorded between ATC and an aircraft that identified itself as American Airlines (AA) flight #1855:

AA1855: *“Okay we uh just popped out at uh sixteen five on top, American eighteen fifty five, but it’s uh...I’ve never seen it worse...uh moderate to heavy icing...uh rime uh rime ice.”*

ATC: *“Okay what’s the outside air temperature?”*

AA1855: *“Four degrees.”*

ATC: *“Minus four C?”*

AA1855: *“No, plus four.”*

ATC: *“Plus four C alright, American uh eighteen fifty five thanks for the PIREP contact New York center thirty two ten, good day.”*

AA1855: *“Thirty two ten uh, American eighteen fifty five, yea warn everybody cause it’s pretty heavy.”*

ATC: *“I’m putting it in now.”*

A summary of interviews conducted with the flight crew of the MD-83 aircraft (American Airlines flight# 1855) that reported moderate to severe rime icing is presented in [Attachment 5](#) to this report.

Statements and pictures provided by the captain of a CRJ aircraft (Air Wisconsin flight# 3737) that was near the accident location near the accident time and who encountered severe icing is presented in Attachment 6 to this report.

In addition, a statement provided by a pilot of a CRJ aircraft (American Eagle flight# 4654) that was very near the accident location near the accident time and who encountered moderate to severe rime icing can be found in Attachment 7 to this report.

Figure 9 provides the flight paths for the three aircraft whose flight crews provided statements to the NTSB regarding their encounters with severe icing.

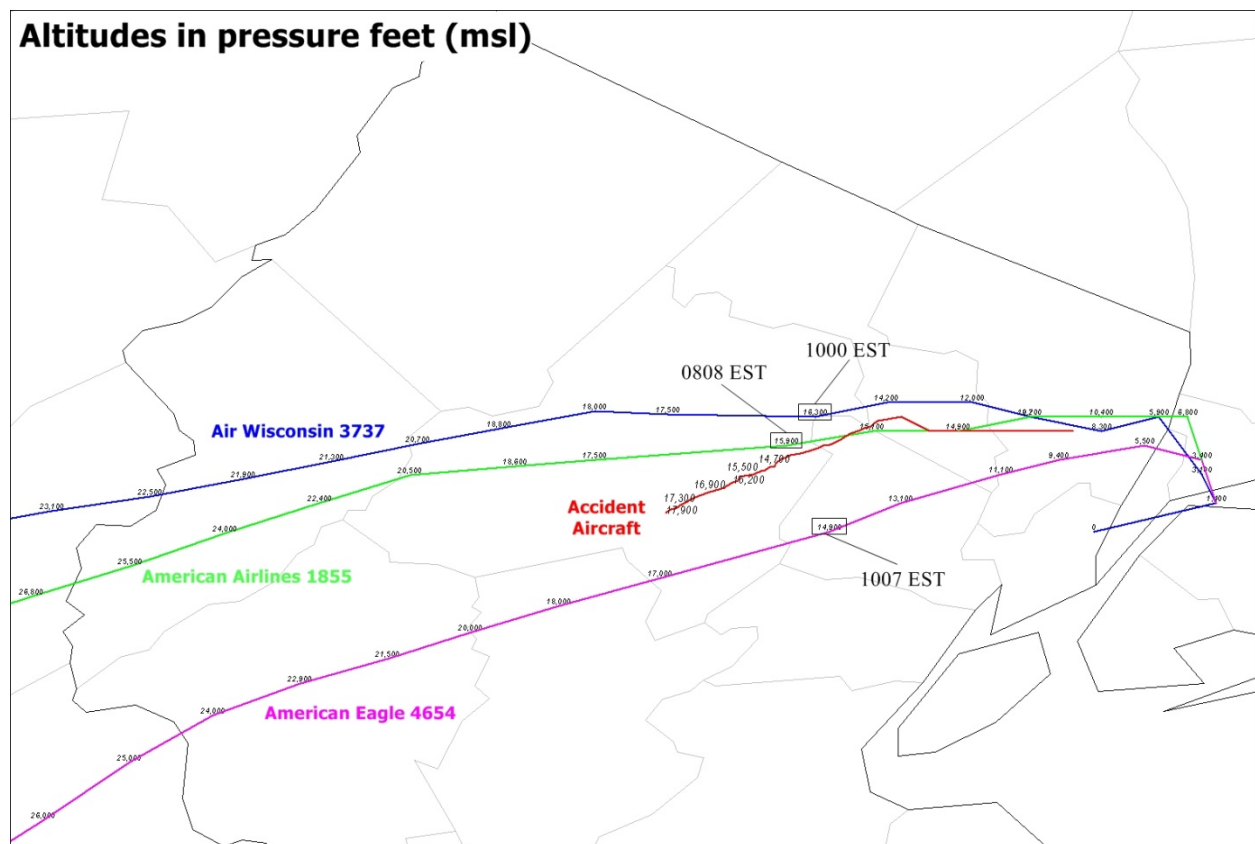


Figure 9 – Flight paths for the three aircraft whose flight crews provided statements to the NTSB regarding their encounters with severe icing. Numbers along flight path indicate altitudes. Times indicate time aircraft was at that location and altitude.

4. Weather Radar

WSR-88D Level-II base reflectivity imagery from Binghamton, New York (KBGM), and Philadelphia, Pennsylvania (KDIX), are presented in figures 10 and 11. These figures also present the final portion of the accident aircraft's flight path above 10,000 feet. Both radars were operating in "clear air mode" during the times surrounding the accident, with KBGM in Volume Coverage Pattern (VCP) 31 and KDIX in VCP 32. VCPs 31 and 32 require the radar antennas to perform 5 distinct elevation sweeps for each volume scan. Total time to complete all 5 elevations sweep is approximately 10 minutes.

KBGM was located approximately 109 miles to the northwest of the accident site. KBGM 0.55° base reflectivity imagery at 1000 EST (figure 10) identified light values of reflectivity¹⁰ in the area of the accident aircraft's flight path. Reflectivity values were generally 5 dBZ or less, however there were a few areas with reflectivity values as high as 9 dBZ. A small "band" to the east of the accident aircraft's flight path just west of New York City exhibited some reflectivity values between 10-15 dBZ. Assuming standard refraction and considering the 0.95° beam width, at the 0.55° tilt KBGM would have "seen" altitudes between about 10,300 and 21,300 feet msl over the accident site.

KDIX was located approximately 50 miles to the south of the accident site. KDIX 2.50° base reflectivity imagery at 1004 EST (figure 11) identified light values of reflectivity in the area of the accident aircraft's flight path. Reflectivity values were generally 5 dBZ or less. A small area to the east of the accident aircraft's flight path near New York City exhibited some reflectivity values between 10-15 dBZ. Due to the scheduling of elevation sweeps for VCP 32, the 2.50° elevation sweep discussed here did not actually initiate until about 1009 EST. Assuming standard refraction and considering the 0.95° beam width, at the 2.50° tilt KDIX would have "seen" altitudes between about 12,500 and 17,600 feet msl over the accident site.

Wind directions and magnitudes were retrieved from KDIX for various altitudes below 20,000 feet. This data is presented in Attachment 8 to this report.

¹⁰ Reflectivity - The sum of all backscattering cross-sections (eg, precipitation particles) in a pulse resolution volume divided by that volume. In order for the radar to calculate the reflectivity, it sends out a small burst of energy. This energy strikes the particles located in the volume. For simplification sake, it is assumed that these particles are evenly spread throughout the volume. The more of these particles located in the volume, the greater the return of energy returned back to the radar. One will see a greater reflectivity return from heavy rain than light rain.

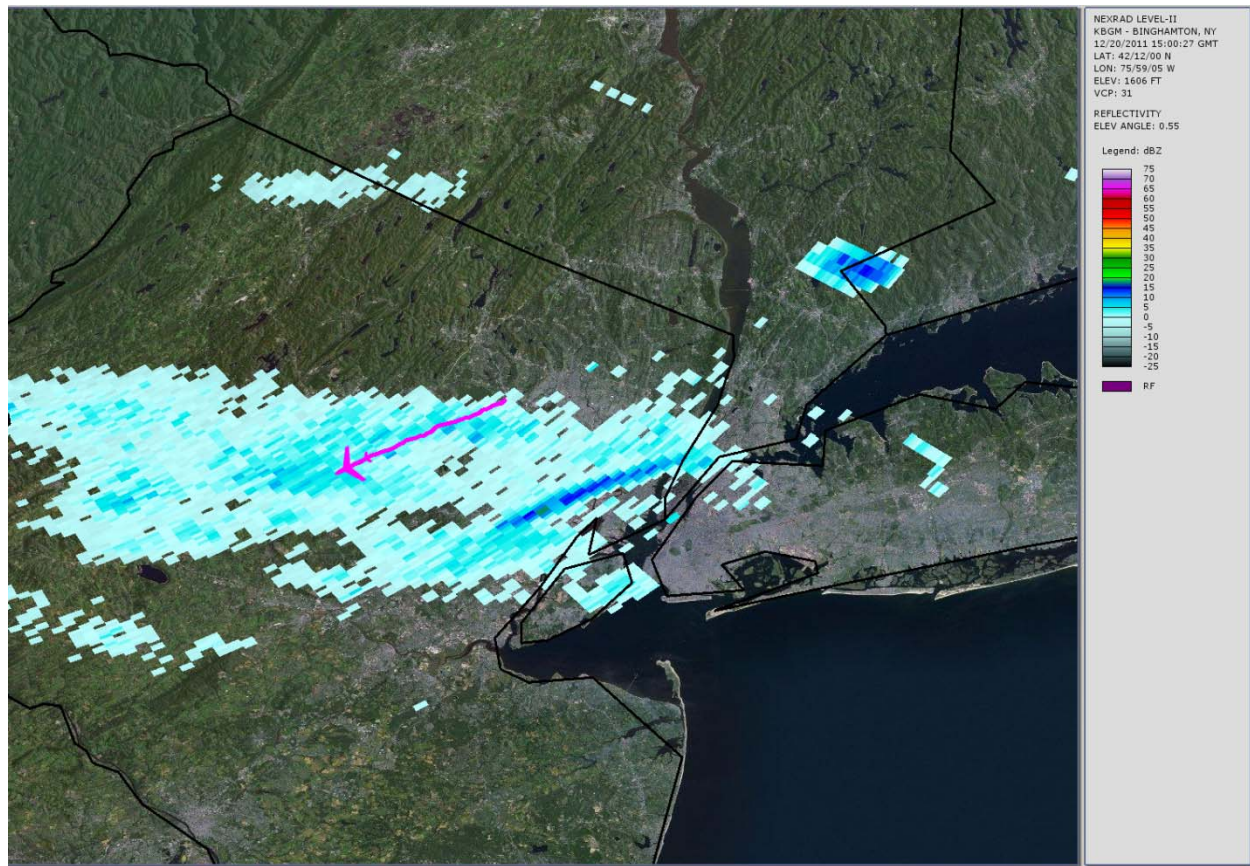


Figure 10 – KBGM 0.55° elevation base reflectivity image from 1000 EST. Aircraft flight path above 10,000 feet shown in pink.

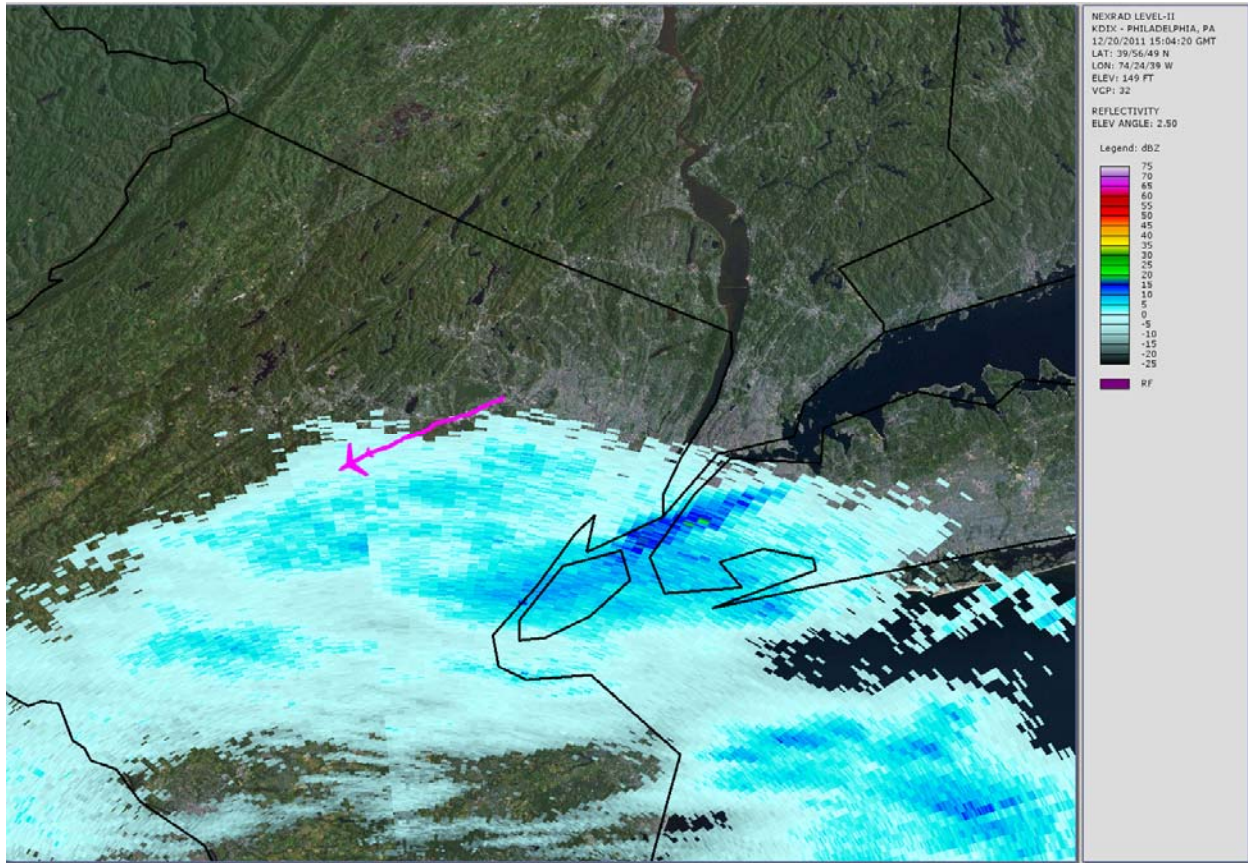


Figure 11 – KDIK 2.50° elevation base reflectivity image from 1004 EST. Aircraft flight path above 10,000 feet shown in pink.

A Vertical-Azimuth Display (VAD) wind profile from Upton, New York (KOKX) at 0933 EST is presented in Figure 12.

A VAD wind profile presents a time series of estimates of the horizontal wind at specific heights above the radar. VAD wind profiles are derived from the root mean square (RMS) of the detected wind velocities and are depicted in terms of the error calculated for the specific wind speed. A green wind barb indicates an RMS VAD wind speed with no calculated error. The WSR-88D radar requires a return from a scattering object to detect wind velocities. The more stable the environment the less error in the detected RMS wind speed.

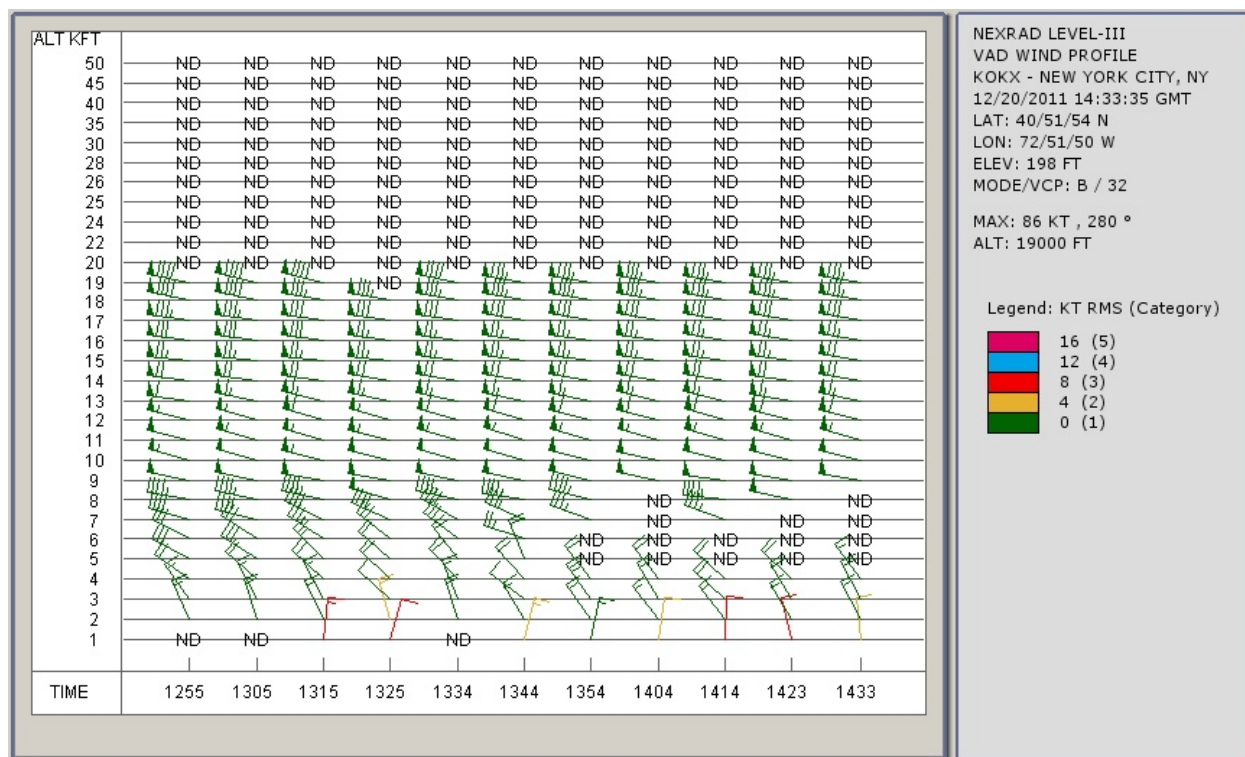


Figure 12 – KOKX VAD wind profile from 0933 EST.

The inference of droplet size from the WSR-88D clear air mode data was not feasible due to the potential for a mixed-phase (water and ice) environment in the region.

5. Satellite Imagery

Geostationary Operational Environmental Satellite (GOES)-11 visible ($0.65\mu\text{m}$) and infrared ($10.7\mu\text{m}$) data were obtained from an archive at the Space Science Engineering Center (SSEC) at the University of Wisconsin-Madison (UW) in Madison, Wisconsin, and processed using the Man computer Interactive Data Access System (McIDAS). Imagery from 1015 EST is presented in figure 13. The GOES-13 visible imagery (figure 13; panel A) identified cloudy conditions over eastern Pennsylvania, New Jersey, and extreme southern New York including Long Island. Cloud-top temperatures in northern New Jersey were retrieved from the GOES-13 infrared data (figure 13; panel B) and varied between -13°C and -22°C . Based on the AMDAR data, these temperatures corresponded to cloud-top heights of approximately 15,500 and 20,500 feet, respectively. A visible/infrared RGB¹¹ composite image (figure 13; panel C), which is comprised of the $0.65\mu\text{m}$ information projected as the red and green colors and the $10.7\mu\text{m}$ information projected as blue, separate higher-topped cloud features (colder, look whiter) from lower-topped clouds (warmer, look more yellow). It should be noted that all satellite data presented in this section have not been corrected for any parallax error.

¹¹ RGB = **R**ed **G**reen **B**lue

Data from the Moderate Resolution Imaging Spectroradiometer (MODIS) were obtained from the National Aeronautics and Space Administration's (NASA) Level 1 and Atmosphere Archive and Distribution System and processed using McIDAS. The 0.65 μ m visible (figure 14; panel A) and 11.0 μ m infrared (figure 14; panel B) data from the MODIS onboard the polar-orbiting TERRA spacecraft provided a unique view of the cloud cover present in the accident region at 1100 EST, approximately one hour after the accident. The MODIS infrared data indicated cloud-top temperatures in northern New Jersey varied between -14°C and -22°C. When considering the AMDAR data, -14°C corresponded to cloud-top heights of approximately 16,000 feet. MODIS "false-color" imagery is presented in figure 14 (panel C), where MODIS 2.11 μ m data (spatial resolution 500 meters) is used as the red component, MODIS 0.85 μ m data (spatial resolution 250 meters) is used as the green component and MODIS 0.65 μ m data (spatial resolution 250 meters) is used as the blue component. This false color imagery attempts to discriminate water cloud (appear more white) from ice cloud and snow on the ground (appears more cyan).

MODIS "true-color" imagery¹² from 1100 EST (figure 15) was created using MODIS 0.65 μ m data as the red color component, MODIS 0.55 μ m data as the green color component, and MODIS 0.47 μ m data as the blue color component, where spatial resolution is 250 meters for red and 500 meters for green and blue.

0.63 μ m (visible) and 10.8 μ m (infrared) data captured at 0915 EST from the Advanced Very High Resolution Radiometer (AVHRR) onboard polar-orbiting satellite MetOP-A were obtained from NOAA and processed using McIDAS. This imagery is presented in figure 16. Cloud-top temperatures in northern New Jersey near the accident location were retrieved from the AVHRR infrared data (figure 16; panel B) and varied between -13°C and -18°C. Based on the AMDAR information, the latter corresponded to cloud-top heights of approximately 18,500 feet.

¹² Obtained from NASA's MODIS Rapid Response system

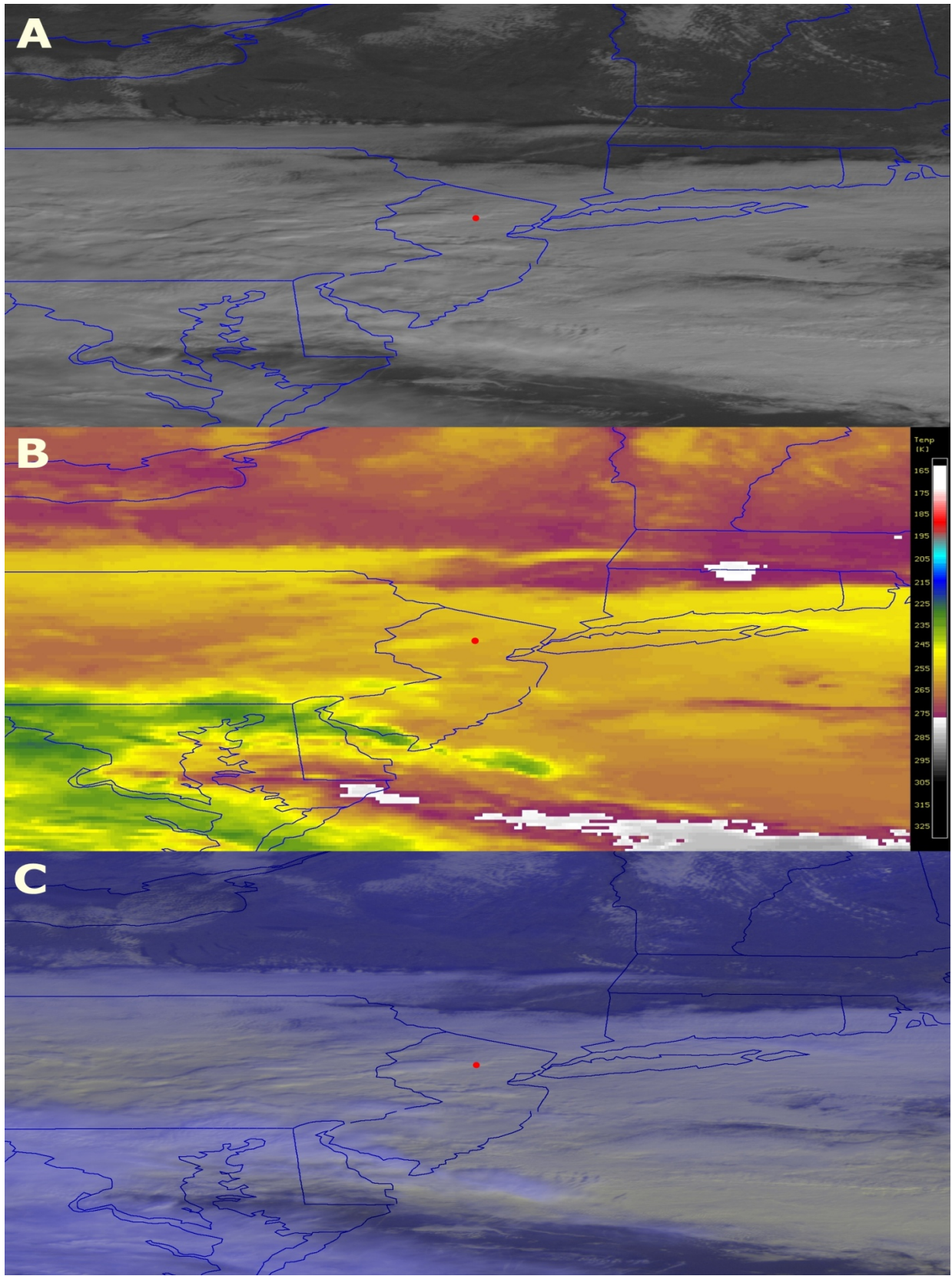


Figure 13 – GOES-13 imagery from 1015 EST. Panel A: 0.65 μm (visible). Panel B: 10.7 μm (infrared). Panel C: Visible/infrared RGB composite. Red circles denote accident location.

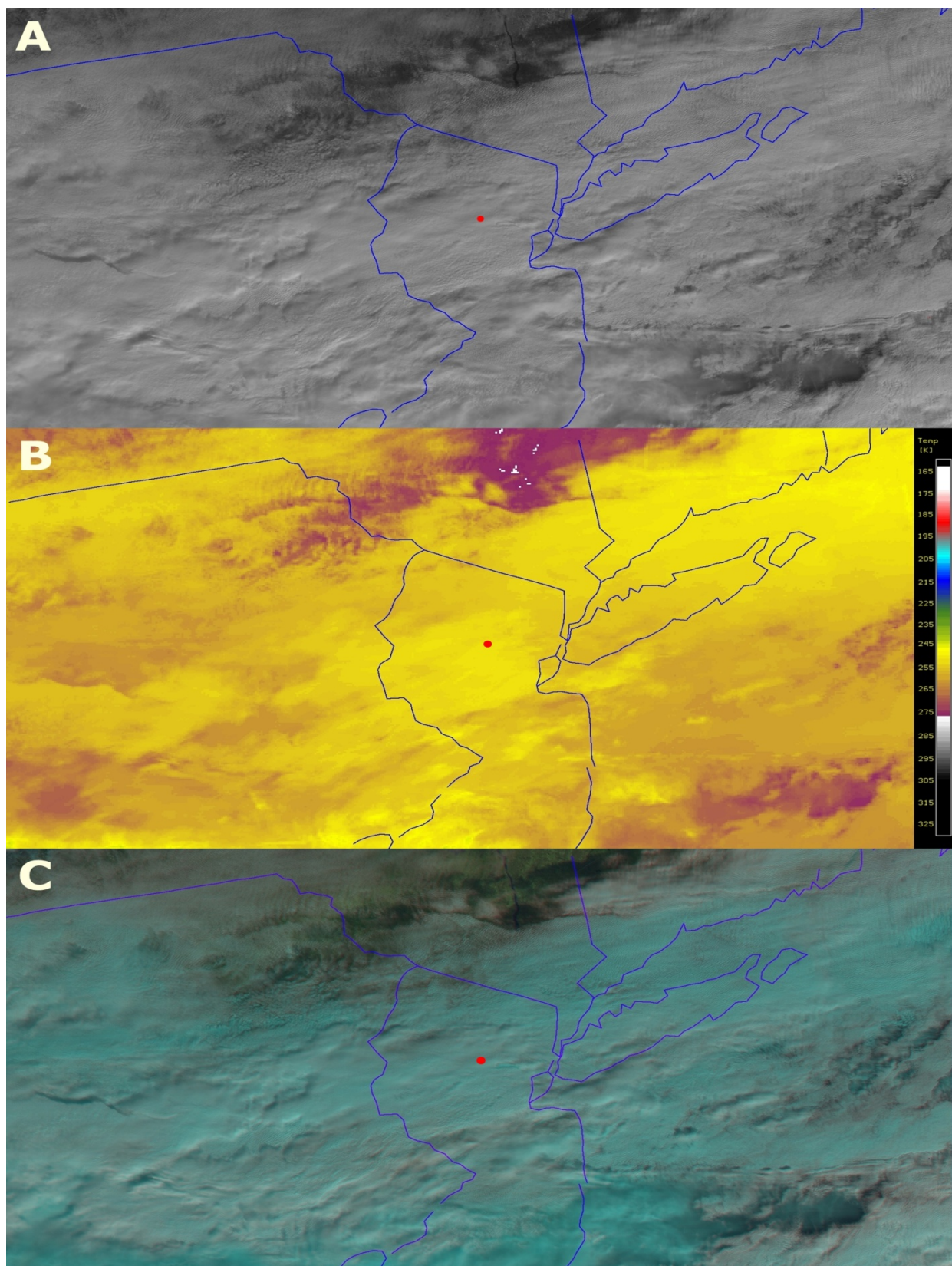


Figure 14 – MODIS imagery from 1100 EST. Panel A: 0.65μm (visible). Panel B: 11.0μm (infrared). Panel C: False color composite. Red circles denote accident location.

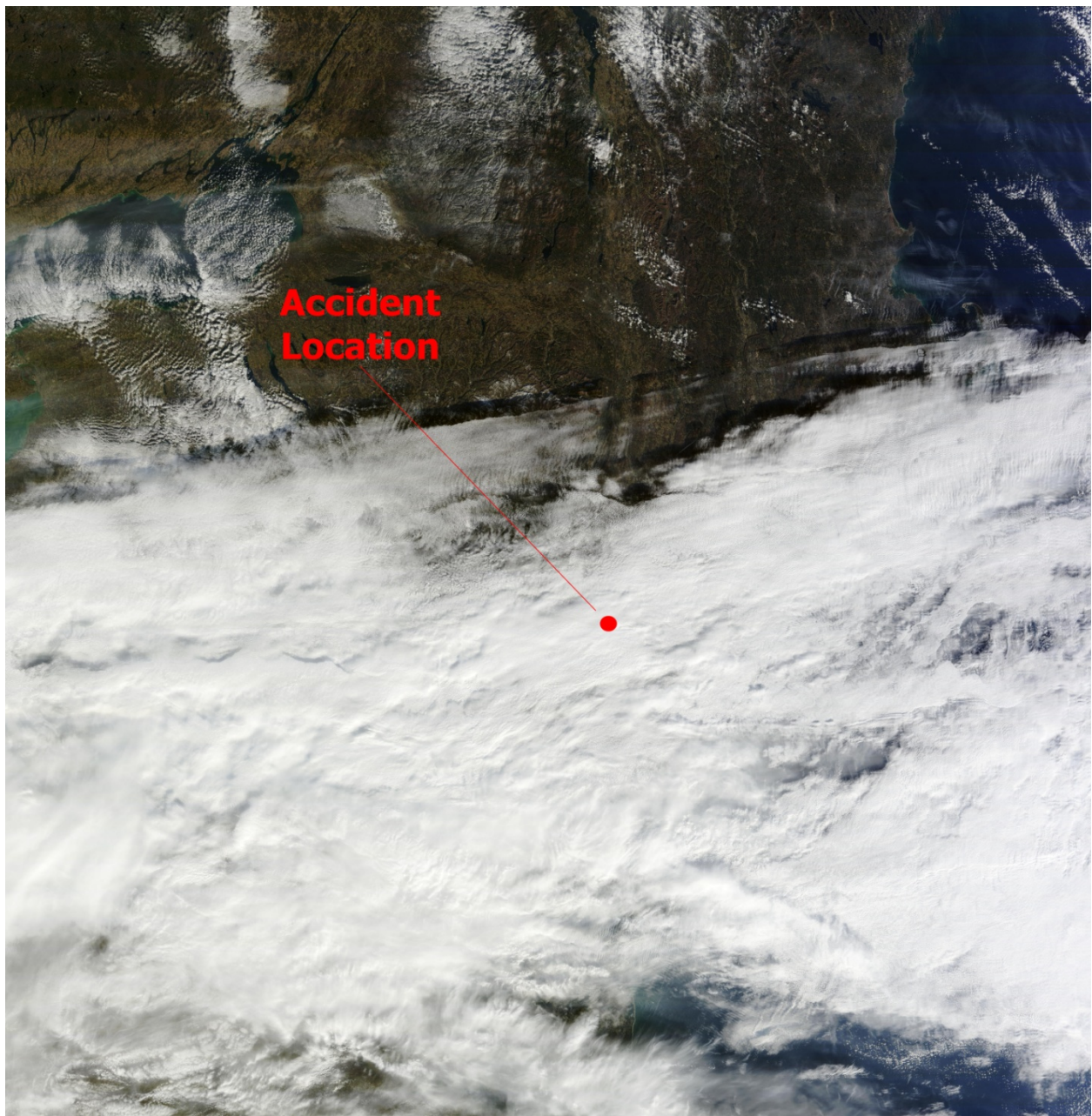


Figure 15 – MODIS true-color imagery from 1100 EST.

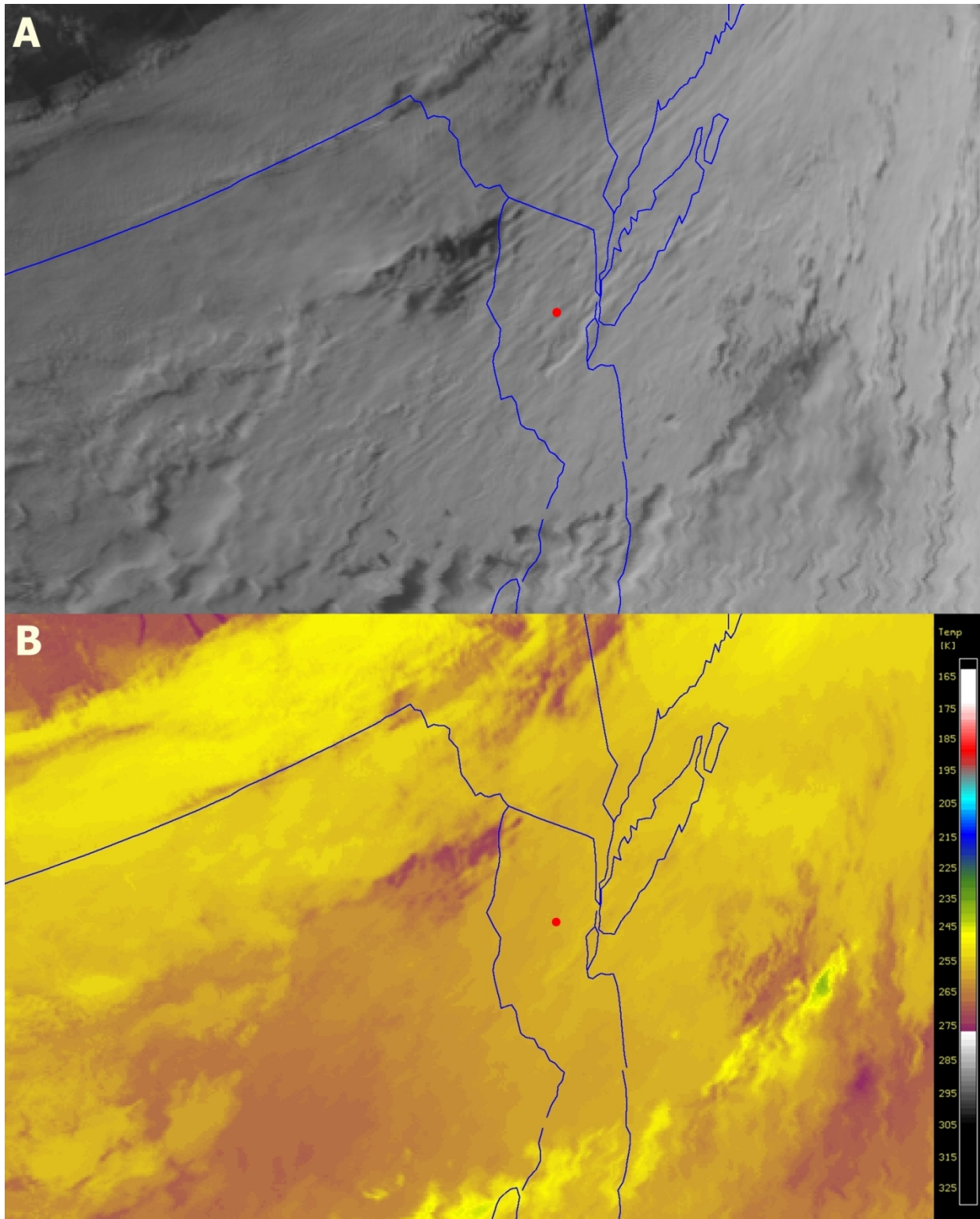


Figure 16 – AVHRR imagery from 0915 EST. Panel A: 0.63μm (visible). Panel B: 10.8μm (infrared). Red circles denote accident location.

6. Terminal Aerodrome Forecasts

A Terminal Aerodrome Forecast (TAF) issued for KEWR at 0931 EST forecasted for the accident time: wind from 360° at 10 knots, visibility greater than 6 miles, ceiling broken at 15,000 feet agl. Conditions forecasted in the TAF are only official for 5 miles from the forecast site and therefore were not official for the accident site.

KEWR 201431Z 2015/2118 **36010KT P6SM BKN150**
FM202100 VRB03KT P6SM FEW060 BKN120
FM210200 17005KT P6SM BKN035 OVC100
FM210900 17005KT P6SM BKN020 OVC035
FM211300 18006KT P6SM SCT007 OVC015=

7. Area Forecast

An amended Area Forecast that included Pennsylvania and New Jersey was issued at 0705 EST and was valid until 1700 EST on December 20, 2011. The portion of the Area Forecast directed toward northern New Jersey forecasted until 1000 EST: ceilings overcast at 7,000 feet, with cloud tops to FL180. The conditions between 1000 and 1600 EST were forecasted as: ceilings broken at 15,000 feet.

FAUS41 KPCI 201205 AAA
FA1W
_BOSC FA 201205 AMD
SYNOPSIS AND VFR CLDS/WX
SYNOPSIS VALID UNTIL 210400
CLDS/WX VALID UNTIL 202200...OTLK VALID 202200-210400
ME NH VT MA RI CT NY LO NJ PA OH LE WV MD DC DE VA AND CSTL
WTRS
.
SEE AIRMET SIERRA FOR IFR CONDS AND MTN OBSCN.
TS IMPLY SEV OR GTR TURB SEV ICE LLWS AND IFR CONDS.
NON MSL HGTS DENOTED BY AGL OR CIG.
.
SYNOPSIS...CDFNT SERN IN THRU SRN NJ INTO ATLC CSTL WTRS. 04Z
QSTNRY FNT E CNTRL IN THRU NRN WV PNHDL INTO CNTRL VA BECMG
CDFNT THRU SERN VA INTO ATLC CSTL WTRS.
.
PA NJ...UPDT
NWRN PA...OVC030 TOP FL180. VIS 3-5SM WDLY SCT -SHRASN BR. 12Z
OVC040. VIS 3-5SM WDLY SCT -SHRASN BR. OTLK...MVFR CIG SHRASN
BR.
SWRN PA...OVC050 TOP FL180. VIS 3-5SM -RA BR. 21Z OVC060.
OTLK...MVFR CIG.

NERN PA...OVC040 TOP FL180. 15Z OVC050. OTLK...VFR.
SERN PA/SRN NJ...OVC060 TOP FL180. 16Z OVC070. OTLK...VFR.
NRN NJ...OVC070 TOP FL180. 15Z BKN150. 21Z OVC120. OTLK...VFR.

8. Area Forecast Discussion

An Area Forecast Discussion was issued at 0956 EST for much of New Jersey from the NWS Forecast Office in Mount Holly, New Jersey. Presented here are portions of that product:

FXUS61 KPHI 201456

AFDPHI

AREA FORECAST DISCUSSION

NATIONAL WEATHER SERVICE MOUNT HOLLY NJ

956 AM EST TUE DEC 20 2011

.SYNOPSIS...

A COLD FRONT FROM THE NORTHWEST WAS MAKING ITS WAY THROUGH OUR REGION EARLY THIS MORNING. THE BOUNDARY IS FORECAST TO STALL JUST TO OUR SOUTH THIS AFTERNOON BEFORE RETURNING TO THE NORTH TONIGHT. LOW PRESSURE LOCATED OVER OKLAHOMA EARLY THIS MORNING WILL PROGRESS TO THE NORTHEAST. THE LOW IS EXPECTED TO PASS ACROSS THE EASTERN GREAT LAKES ON WEDNESDAY AFTERNOON AND EVENING BEFORE REACHING NORTHERN NEW ENGLAND ON WEDNESDAY NIGHT. WEAK HIGH PRESSURE IS FORECAST TO FOLLOW FOR THURSDAY. LOW PRESSURE APPROACHING FROM THE SOUTHWEST IS ANTICIPATED TO PASS ACROSS THE DELMARVA REGION LATE ON THURSDAY NIGHT. ANOTHER AREA OF LOW PRESSURE IS EXPECTED TO FOLLOW OVER THE WEEKEND.

&&

.NEAR TERM /UNTIL 6 PM THIS EVENING/...

A WEAK CDFNT WAS CROSSING THE AREA AND WAS JUST SOUTH OF A PHL TO BLM LINE LATE THIS MORNING. SOME WEAK SURFACE CONVERGENCE WITH THE FRONT, MODEST ISENTROPIC LIFT AND WEAK MID LEVEL ENERGY WERE COMBINING TO TRIGGER SOME VERY LIGHT RAIN NEAR AND SOUTH OF THE FRONT. THESE FACTORS SEEM TO CONTINUE THROUGH THE AFTERNOON IF THE LATEST NAM RUN IS TO BE BELIEVED. THE FAVORED AREA IS PROGGED TO SHIFT A LITTLE FURTHER SOUTH BEFORE BEGINNING TO MOVE BACK NORTH AS THE FRONT STALLS BY DUSK. PRECIPITATION IS EXPECTED TO BE MOSTLY RAIN AND MOSTLY VERY LIGHT. SOME VERY LIGHT SNOW CAN'T BE RULED OUT LATER IN THE DAY FAR NORTHWEST. TEMPERATURES RENT EXPECTED TO RISE A LOT TODAY.

&&

.AVIATION /15Z TUESDAY THROUGH SATURDAY/...

THE FOLLOWING DISCUSSION IS FOR KPHL, KPNE, KTTN, KABE, KRDG,

KILG, KMIV, KACY AND SURROUNDING AREAS.

AN AREA OF HIGH MVFR CLOUDINESS NEAR AND NORTH OF THE FRONT WAS EXPECTED TO LINGER THROUGH MUCH OF THE DAY BUT MAY LIFT JUST ENOUGH AND SCATTER JUST ENOUGH TO MAKE FOR MORE VFR THAN MVFR CONDITIONS DURING THE DAYLIGHT HOURS. ANY VERY LIGHT RAIN IS NOT EXPECTED TO CAUSE VISIBILITY RESTRICTIONS.

WHERE IT HASN'T ALREADY DONE SO AS OF LATE THIS MORNING, THE WIND WILL SHIFT TO THE NW AND THEN N BEHIND THE FRONT TODAY. THE FRONT WILL RETURN NWD AS A WARM FRONT TONIGHT, CAUSING THE WINDS TO SHIFT BACK TO THE SE. WIND SPEEDS ARE EXPECTED TO REMAIN BELOW 10 KTS.

THERE COULD BE A PERIOD OF PRECIPITATION OVERNIGHT, MAINLY FOR THE WRN TAF SITES, BUT IT IS EXPECTED TO BE LIGHT AND CONDS PRESENTLY ARE FORECAST TO BE VFR. HOWEVER, ESPECIALLY FOR KABE, DEPENDING ON LOW TEMPS TONIGHT, THERE COULD BE SOME WINTRY PRECIP DURG THIS TIME.

OUTLOOK...

LOW CEILING AND VISIBILITY VALUES ARE LIKELY FOR WEDNESDAY INTO WEDNESDAY EVENING AS RAIN OVERSPREADS OUR REGION. SOME IMPROVEMENT IS ANTICIPATED FOR LATE WEDNESDAY NIGHT INTO THURSDAY. HOWEVER, ANOTHER ROUND OF RAIN, LOW CLOUDS AND REDUCED VISIBILITY VALUES IS ANTICIPATED FOR THURSDAY NIGHT INTO FRIDAY MORNING. ANOTHER AREA OF LOW PRESSURE MAY IMPACT OUR REGION OVER THE WEEKEND.

&&

SYNOPSIS...IOVINO/DELISI

NEAR TERM...NIERENBERG/DELISI

SHORT TERM...NIERENBERG

LONG TERM...IOVINO

AVIATION...IOVINO/NIERENBERG/DELISI

MARINE...IOVINO/NIERENBERG

TIDES/COASTAL FLOODING...IOVINO

9. Low Level Significant Weather Charts

Low level Significant Weather 12-hour forecast charts valid for the times surrounding the accident time are presented in figures 17 and 18. This product is a forecast of aviation weather hazards and is primarily intended to be used as a guidance product for briefing the VFR pilot. It does not explicitly depict icing hazards. It does, however, identify the forecast height of the freezing level. During the times surrounding the accident, the freezing level height of 4,000 feet was found in central New Jersey, just south of the accident site. At 0700 EST, the freezing level at the surface was found on the New Jersey/New York border, while at 1300 EST, the freezing level at the surface was found in central New York.

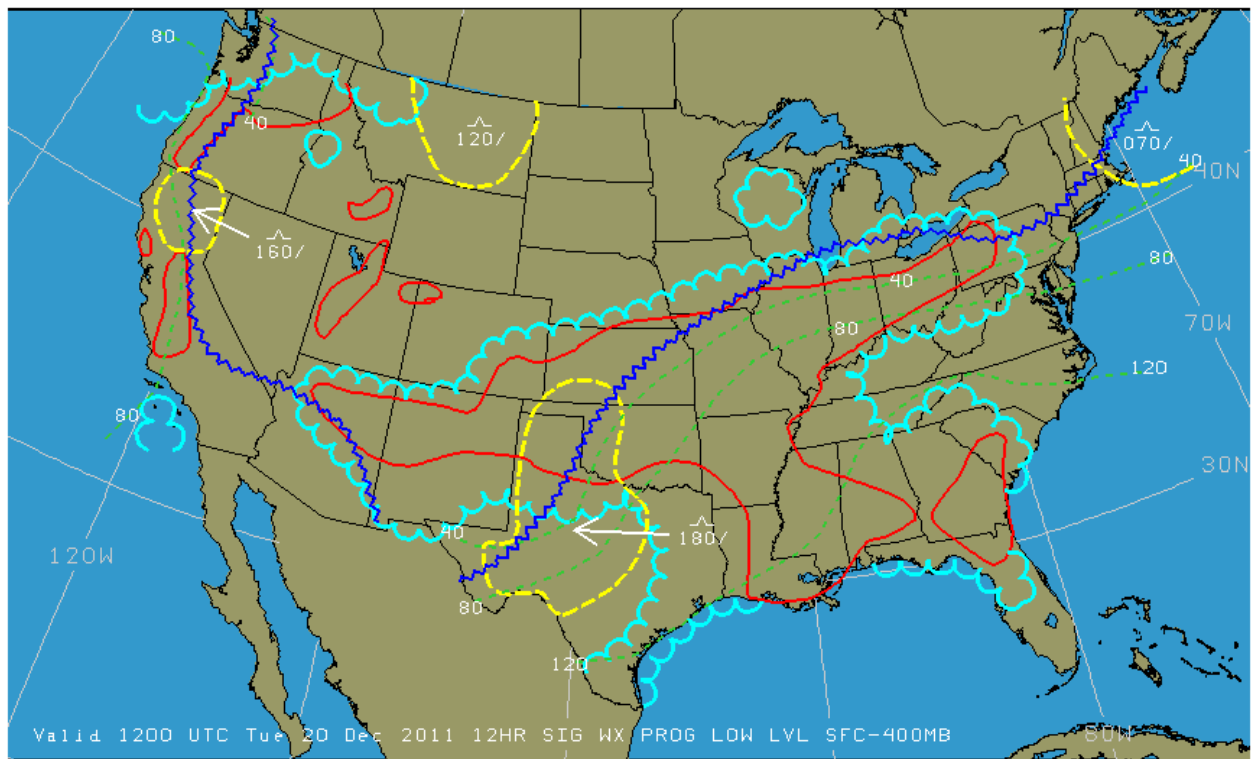


Figure 17 – 12-hour Low level Significant Weather chart for 0700 EST.

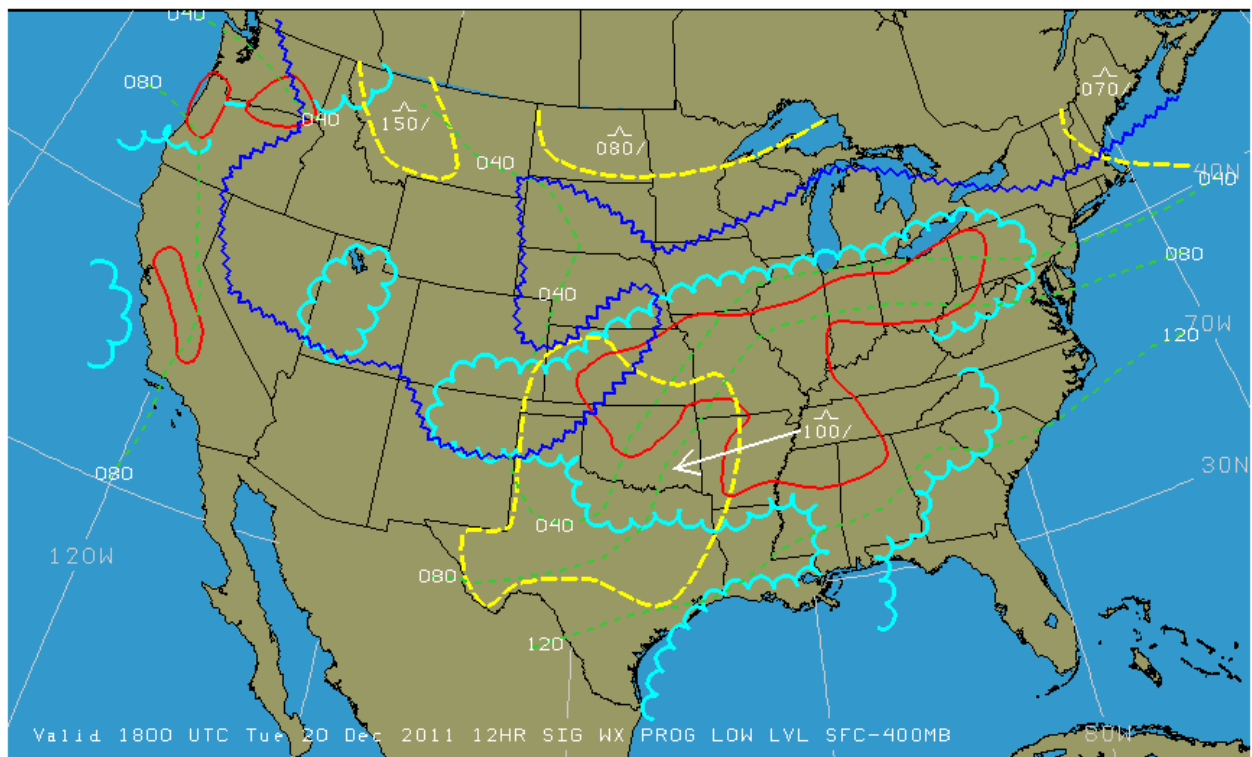


Figure 18 – 12-hour Low level Significant Weather chart for 1300 EST.

10. Aviation Weather Center Products

An Airmen's Meteorological Information (AIRMET) advisory ZULU for moderate icing between the freezing level (identified as located between 2,000 and 8,000 feet) and FL200 was issued at 0945 EST for the accident location (figure 19).

WAUS41 KPCI 201445

WA1Z

_BOSZ WA 201445

AIRMET ZULU UPDT 3 FOR ICE AND FRZLVL VALID UNTIL 202100

.

AIRMET ICE...MA RI CT NY NJ PA OH LE WV MD DC DE VA AND CSTL WTRS

FROM DXO TO 150ESE ACK TO 200SE ACK TO 160SE SIE TO 40WSW SBY TO HNN TO CVG TO FWA TO DXO

MOD ICE BTN FRZLVL AND FL200. FRZLVL 020-080. CONDS CONTG BYD 21Z THRU 03Z.

Prior to the 0945 EST AIRMET ZULU, an amended AIRMET ZULU for moderate icing between the freezing level (identified as located between 3,000 and 9,000 feet) and FL180 was issued at 0658 EST for the accident location (figure 19).

WAUS41 KPCI 201158 AAA

WA1Z

_BOSZ WA 201158 AMD

AIRMET ZULU UPDT 2 FOR ICE AND FRZLVL VALID UNTIL 201500

.

AIRMET ICE...NY NJ PA OH LE WV MD DC DE VA AND CSTL WTRS...UPDT FROM DXO TO 40SSE HNK TO 70SSW ACK TO 130ESE ACK TO 200SE ACK TO 180SE SIE TO 20W RIC TO 50W CSN TO HNN TO CVG TO FWA TO DXO

MOD ICE BTN FRZLVL AND FL180. FRZLVL 030-090. CONDS CONTG BYD 15Z THRU 21Z.

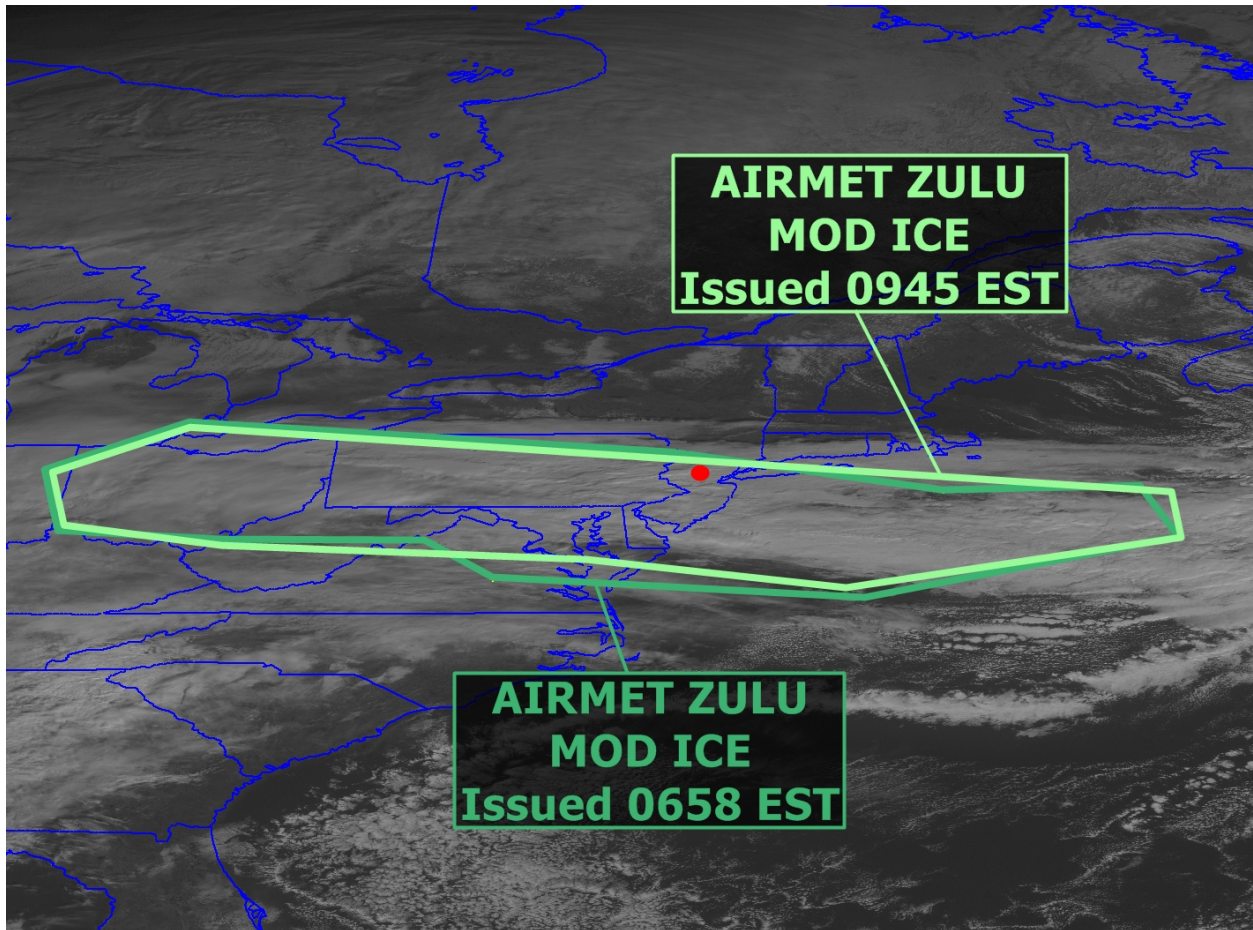


Figure 19 – AIRMET ZULUs active for the accident location surrounding the accident time. Red dot denotes accident location.

No Significant Meteorological Information (SIGMET) advisories were in effect for the times surrounding the accident near the accident location.

Attachment 9 to this report presents the Shift Log from the Aviation Weather Center (AWC) for the day of the accident.

Attachment 10 to this report presents the NWSChat log provided by the AWC for the day of the accident.

A summary of an interview with the Domestic Operations Branch Chief at the AWC is provided as Attachment 11 to this report.

A written statement provided by a meteorologist on duty at the AWC on the morning of the accident is provided as Attachment 12 to this report.

A summary of an interview with a meteorologist on duty at the AWC on the morning of the accident is provided as Attachment 13 to this report.

11. Center Weather Service Unit Products

No Meteorological Impact Statements were issued for the accident location prior to accident time.

At 1120 EST, the Center Weather Service Unit (CWSU) at ZNY issued a Center Weather Advisory (figure 20) for the accident location that advised of moderate icing between 11,000 feet and FL180, with isolated severe icing possible, especially with smaller aircraft.

FAUS21 KZNY 201624

ZNY1 UCWA 201620

ZNY UCWA 101 VALID UNTIL 201820

FM SAX TO 20NW ETX TO CYN TO 20E JFK TO SAX

**MOD ICING IS LIKELY FM 110 TO FL180 WITH ISOL SEV ICING PSBL
ESPECIALLY WITH SMALLER AIRCRAFT.**

KS

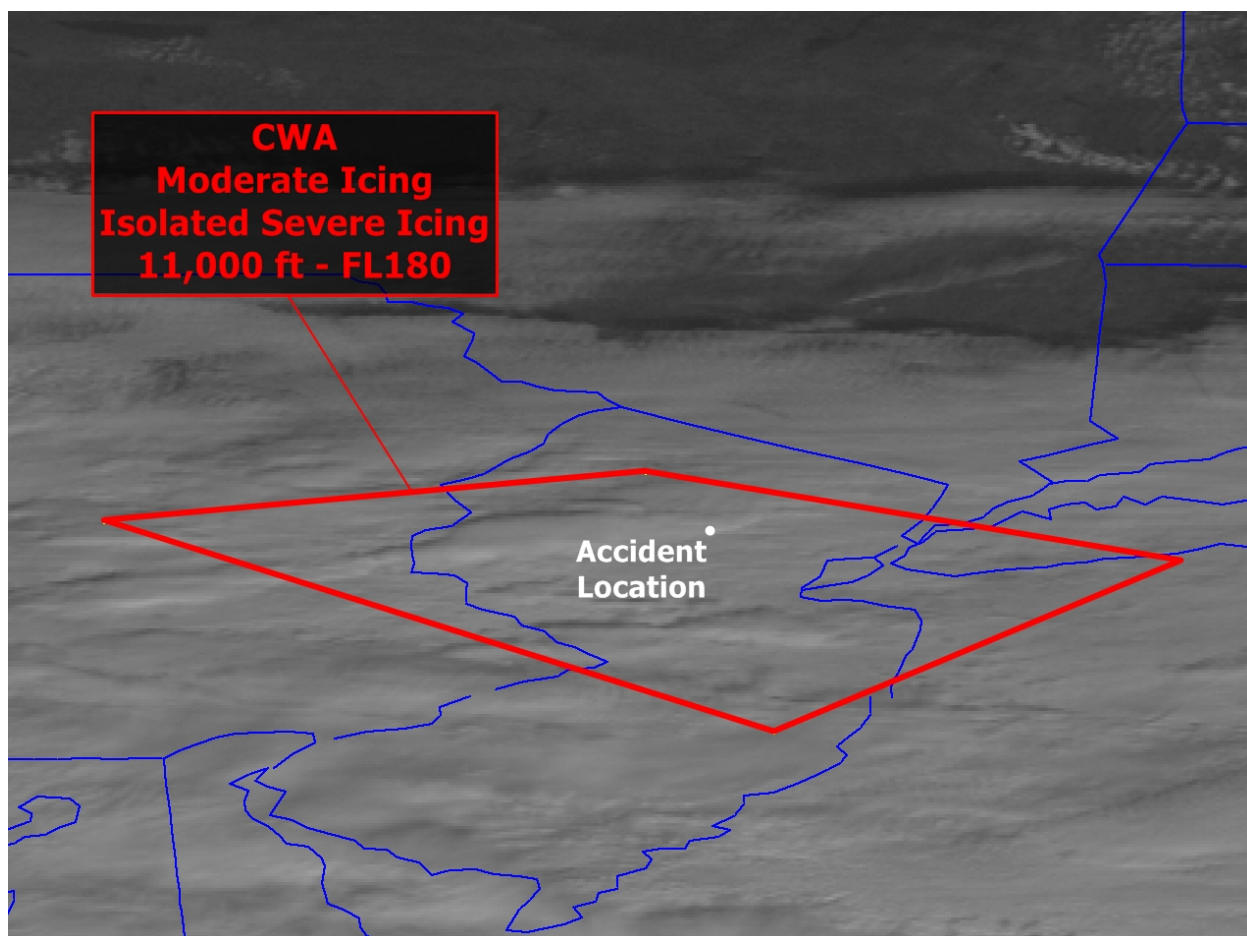


Figure 20 – CWA issued by ZNY CWSU at 1120 EST.

The following “experimental” graphical products (figures 21 and 22) were issued by the CWSU at ZNY to New York TRACON prior to the accident.

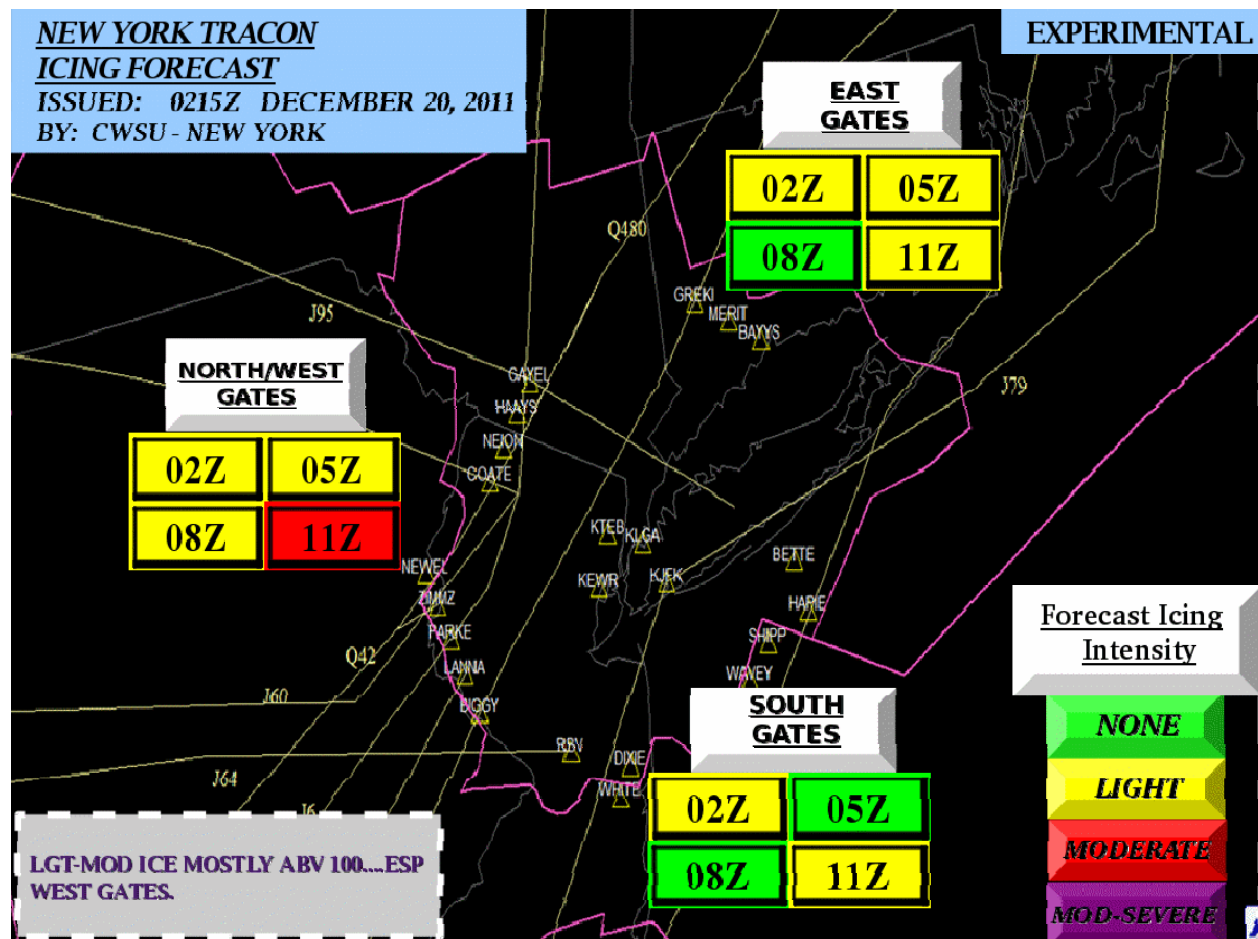


Figure 21 – Forecast icing intensity for New York TRACON issued at 2115 EST on December 19, 2012.

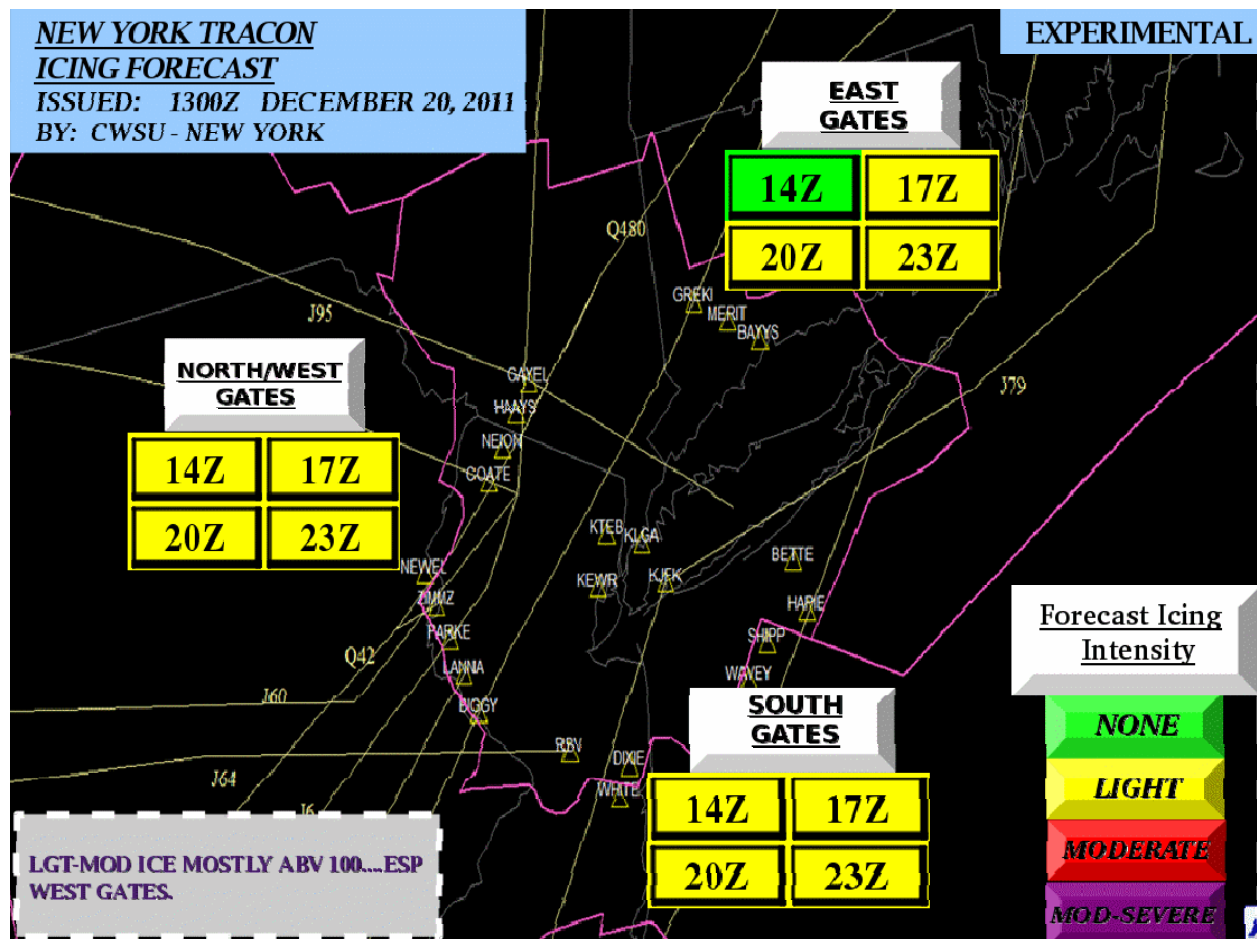


Figure 22 – Forecast icing intensity for New York TRACON issued at 0800 EST.

Attachment 14 to this report presents an outline of a briefing given by an NWS forecaster working at New York TRACON (N90) to the N90 Supervisory Traffic Management Coordinator at 0705 EST on the morning of the accident.

A summary of an interview with the CWSU Program Lead at NWS headquarters is provided as Attachment 15 to this report.

A summary of an interview with a NWS meteorologist positioned at N90 on the morning of the accident is provided as Attachment 16 to this report.

A written statement provided by the CWSU meteorologist on duty at ZNY on the morning of the accident is provided as Attachment 17 to this report.

A summary of an interview with the CWSU meteorologist on duty at ZNY on the morning of the accident is provided as Attachment 18 to this report.

Attachment 19 to this report presents the Shift Log from the ZNY CWSU for the times surrounding the accident.

On April 13, 2012, the Meteorology Group spoke with Ms. Kristine Nelson, the Meteorologist In Charge at the CWSU at Anchorage Center (ZAN). Ms. Nelson was contacted by the Meteorology Group after the group learning of a “decision tree” that is in place at the ZAN CWSU to assist meteorologists in determining the need to issue CWAs for severe icing. Ms. Nelson indicated that the decision tree was created to keep the vision on advisories and highlight the importance of certain meteorological information. Ms. Nelson noted that the ZAN CWSU has a large physical area of concern, and there is not a lot of data available to support their work. Ms. Nelson also emphasized the need for PIREPs. When asked if the decision tree was strict criteria for the forecasters when it came to the issuance of CWAs for severe icing, Ms. Nelson stated that it was not and that advisories were still issued at a forecaster’s discretion. Ms. Nelson was not aware of whether or not the decision tree had been shared with other NWS facilities.

12. Additional NWS/Federal Aviation Administration Information

Attachment 20 to this report presents AIRMETs and PIREPs from the day of the accident as provided by the NWS.

Attachment 21 to this report presents the NWSChat log provided by the NWS Weather Forecast Office (WFO) in Upton, New York, for the day of the accident.

Attachment 22 to this report presents the Station Log from the NWS WFO in Upton, New York, for the times surrounding the accident.

Attachment 23 to this report presents a Federal Aviation Administration (FAA) shift log from the day of the accident.

13. Pilot Weather Briefing

The accident pilot did not receive a DUAT, DUATS or Lockheed Martin Flight Services telephone weather briefing prior to the accident flight. It is not known if the pilot received pre-flight weather information from another source or if the pilot consulted the Aviation Digital Data Service prior to the accident flight.

14. Astronomical Data

The astronomical data obtained from the United States Naval Observatory for 40.8°N and 74.5°W on Thursday, December 20, 2011, indicated the following:

SUN	
Sunrise	0718 EST
Sun transit	1155 EST
Sunset	1633 EST

MOON	
Moonrise	0235 EST
Moonset	1307 EST

F. LIST OF ATTACHMENTS

- Attachment 1: Data and analysis from AirDat LLC, as well as flight paths from two TAMDAR reporting aircraft operating near the accident site near the accident time.
- Attachment 2: A large TAMDAR dataset provided by AirDat LLC.
- Attachment 3: Images presenting output from the CIP and the FIP surrounding the time of the accident.
- Attachment 4: Pilot reports made over New Jersey, southern New York, and eastern Pennsylvania between 0700 and 1300 EST.
- Attachment 5: A summary of interviews conducted with the flight crew of the MD-83 aircraft (American Airlines flight# 1855) that reported moderate to severe rime icing.
- Attachment 6: Statements and pictures provided by the captain of a CRJ aircraft (Air Wisconsin flight# 3737) that was near the accident location near the accident time and who encountered severe icing.
- Attachment 7: Statement provided by a pilot of a CRJ aircraft (American Eagle flight# 4654) that was very near the accident location near the accident time and who encountered moderate to severe rime icing.
- Attachment 8: Wind directions and magnitudes retrieved from KDIX for various altitudes below 20,000 feet.
- Attachment 9: Shift Log from the AWC for the day of the accident.
- Attachment 10: NWSChat log provided by the AWC for the day of the accident.
- Attachment 11: Summary of an interview with the Domestic Operations Branch Chief at the AWC.

- Attachment 12: Written statement provided by a meteorologist on duty at the AWC on the morning of the accident.
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- Attachment 16: Summary of an interview with a NWS meteorologist positioned at N90 on the morning of the accident.
- Attachment 17: Written statement provided by the CWSU meteorologist on duty at ZNY on the morning of the accident.
- Attachment 18: Summary of an interview with the CWSU meteorologist on duty at ZNY on the morning of the accident.
- Attachment 19: Shift Log from the ZNY CWSU for the times surrounding the accident.
- Attachment 20: AIRMETs and PIREPs from the day of the accident as provided by the NWS.
- Attachment 21: NWSChat log provided by the NWS WFO in Upton, New York, for the day of the accident.
- Attachment 22: Station Log from the NWS WFO in Upton, New York, for the times surrounding the accident.
- Attachment 23: FAA shift log from the day of the accident.

Submitted by: Mike Richards
NTSB, AS-30